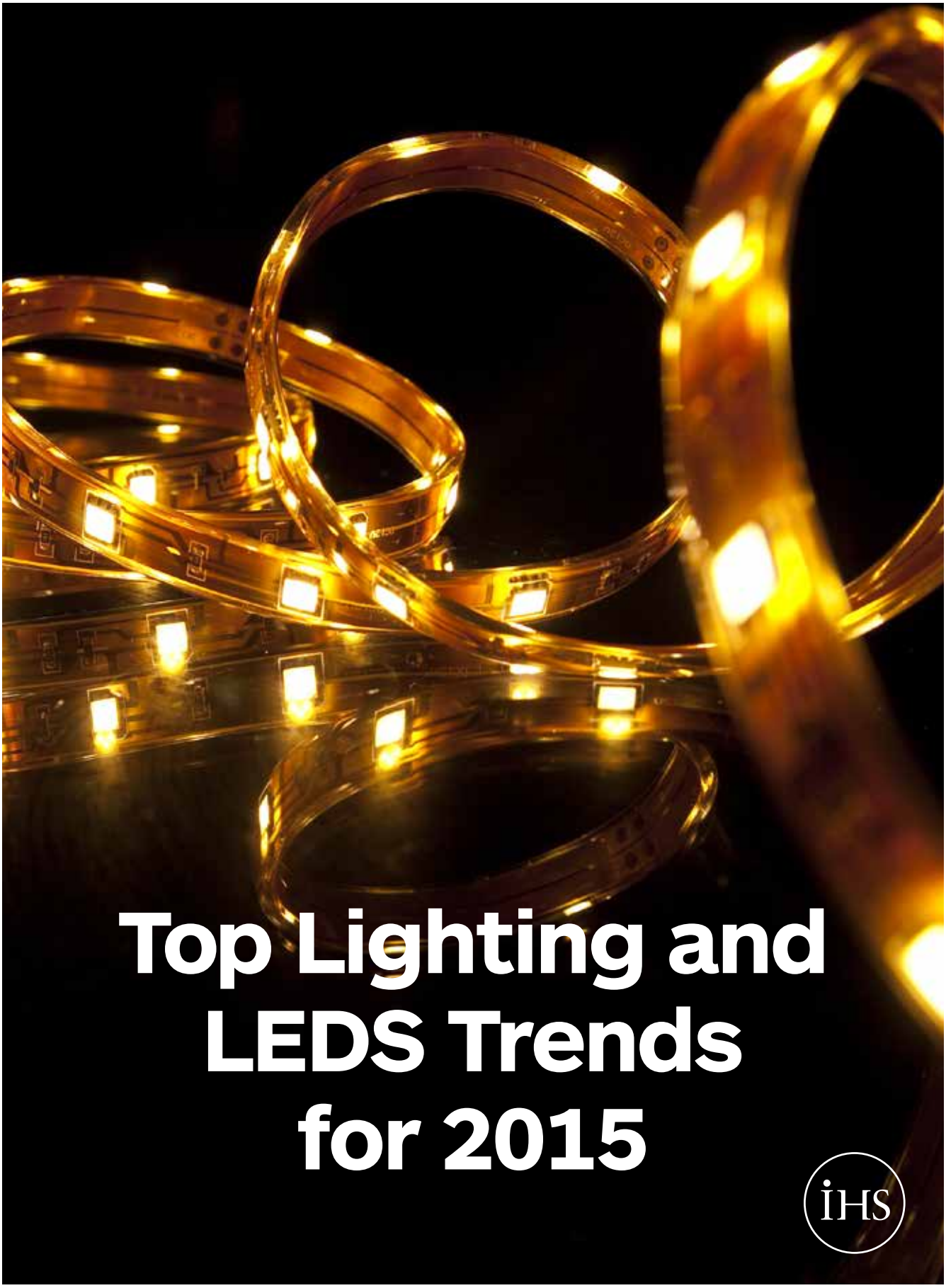

Top Lighting and LEDS Trends for 2015

Welcome to the IHS guide to the top 10 trends that we predict will make an impact on the lighting and light-emitting-diode (LED) industry in 2015.

Our team of dedicated lighting and LED analysts based across the world have come together to highlight the following trends to watch in 2015:

- China—the LED dragon—continues to grow
- Sky's the limit for cloud-based smart lighting
- Changing fortunes for lighting companies in 2015?
- Li-Fi, a brighter way to communicate
- Is lighting poised for a quantum leap?
- OLED luminaires, and where to purchase them
- LED filament bulbs: incandescent beauty with an LED twist
- Packaged LED industry is moving downstream and getting smarter
- Is your street light all that it seems?
- Automotive applications driving optoelectronic components market

If you would like to speak with one of our analysts on any of the topics covered in this white paper, or to discuss our LED and Lighting service offering, please contact us.

Thank you,

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For more information on this white paper, refer to the Lighting & LEDs research service, under the Industrial, Security & Medical Technology division, of IHS Technology.

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ONE

China—the LED dragon—continues to grow

As the largest lighting production base in the world, China has seen its LED industry grow very rapidly in the past few years in the face of the country's increased adoption of LED technology

Starting from 2010 with subsidies from Beijing on metal organic chemical vapor deposition (MOCVD) tools, a huge number of new players entered the industry and then purchased hundreds of MOCVD tools to produce LED dice. While many have since gone out of business or have been bought up by other companies, the survivors have become larger and stronger, playing an increasingly important role on the world LED lighting stage.

San'an is a typical example. Its 2-inch-equivalent wafer capacity share was about 2 percent of the world market in the fourth quarter of 2010, and now is forecast to exceed 14 percent by the end of 2015. Moreover, its technology has improved over this period, and San'an is taking share from Taiwanese, Korean and other international LED companies.

The Chinese boom in the upstream LED market may be attributed to government support. However, IHS is also starting to see a similar development in the packaged LED market. In early 2014, MLS, the largest Chinese packaged LED manufacturer, entered for the first time the list of the largest 10 global LED companies. Expanding quickly since then and now consuming 20 billion LED die per month, MLS at present is the largest packaged LED manufacturer in the world in terms of capacity, and was the seventh biggest revenue generator in the third quarter of 2014.

Finally, with tens of thousands of lighting companies, China has become one of the world's largest production bases—a status likely to continue for many years. Most Chinese lighting companies have been looking intently at the opportunities that LED lighting brings, and as a result have quickly converted their traditional businesses to LED lamp production. In fact, some of the largest companies now have the capacity to produce more than 10 million LED bulbs per month. These companies, however, are also looking to create their own brand to compete internationally. For instance, OPPLE had a reasonably sized presence at the 2014 Light and Building show in Frankfurt, Germany.

The year 2015 could certainly be pivotal for the global LED industry given the growing market share of Chinese LED companies throughout the value chain. But in order to compete with international companies and maintain their growth, Chinese vendors must overcome perceptions on product quality that continue to plague them, even while they maintain their low pricing.

TWO

Sky's the limit for cloud-based smart lighting

Cloud computing has become an integral part of daily living, with consumers using cloud-based services to check bank balances, send emails and update their Facebook status. Cloud computing is now even allowing building owners and facility managers to control and optimize their lighting systems remotely.

Traditional lighting controls enable users to switch, dim, schedule, color-tune and generally automate their lighting. Cloud-based lighting controls can do all of this but also add remote-control capabilities.

Why is this important?
Facility managers may be charged with looking after and driving down energy consumption across hundreds, if not thousands, of buildings across an entire portfolio. To this end, cloud-based lighting controls can aggregate every lighting system from every building, enabling facility managers to remotely monitor occupancy, energy consumption and system usage.

An entire portfolio of building lighting control systems connected by the cloud will produce a tremendous amount of data. Data-driven building analytics, in turn, can be used to automatically evaluate and diagnose a variety of issues in buildings, from fault detection to optimizing energy. Such a solution enables the initial install, as well as ongoing management, of the buildings to be centrally managed. The rollout of building analytics over a portfolio can be as fast as it takes to install the software into a server in a single building.

Cloud-based lighting controls can also be an attractive proposition for customers who do not have the budget for a large upfront capital outlay, since the mechanism can accommodate a smaller charge on a monthly basis.

Cloud-based lighting control companies can offer a variety of solutions, ranging from a monthly rental of the controls, to just providing access to an online control portal.

The recurring monthly revenue (RMR) business model could be very lucrative for lighting companies to try to identify ways to leverage against falling non-LED lighting sales. However, it is quite a steep change for companies that are used to ad-hoc sales of equipment.

So, will 2015 be the year for cloud-based smart lighting?
IHS believes the market is unlikely to see cloud-based smart lighting gain market share in 2015 because public knowledge of companies offering solutions remains limited. Still, the silver lining is that cloud-based smart lighting could gain mindshare in 2015.

THREE

Changing fortunes for lighting companies in 2015?

It was clearly not smooth sailing for the top lighting manufacturers in 2014, so what is the outlook for 2015?
For the big three lighting suppliers, the road was bumpy with all of them recording falling revenue in the three first quarters of 2014. How can these giants of the lighting industry turn this around?

On September 23, 2014, Philips announced it would be splitting its business into two parts: HealthTech, which will combine Philips Healthcare and Consumer Lifestyle ranges; and Lighting Solutions, which will be a standalone lighting company. Both will continue to operate under the Philips brand, but Philips expects to save approximately €300 million from the present to 2016. The company could then potentially price its lamps more aggressively and take back market share it has lost in some areas. By splitting up, the Dutch giant will produce smaller entities that are more dynamic and will be able to react more quickly to changing market dynamics.

This move by Philips follows a similar corporate strategy from Siemens AG last year, when it spun off Osram and listed the new firm on the Frankfurt Stock Exchange. What followed were large-scale job cuts in order to streamline the new company and to make it more profitable. Osram could then focus on core growth areas and invest in those businesses, such as the Specialty Lighting and Opto Semiconductors business lines. Osram's general illumination divisions have been struggling, and are implementing large-scale restructuring programs, which they hope should lead to revenue growth and higher margins in the coming quarters.

It is likely that similar cuts could be under way at Philips Lighting. What could emerge would be a more streamlined and efficient company that can compete with some of the upcoming dynamic players in the LED lighting market, such as U.S.-based Cree, Swiss-headquartered TCP and South Korea's LG.

Meanwhile, rumors have been circulating about a possible split in the lighting business of GE, with the giant company recently selling its appliances business to Electrolux for $3.3 billion in September to focus on higher-margin industrial and infrastructure markets. GE's lighting business is more consumer-focused, so it can be spun off in the future, even if it has struggled more than Philips and Osram in recent years given the firm's relatively slow adoption of LED technology, partly because it is not vertically integrated. However, GE has taken steps to change this with the recent opening of a new production area for the manufacture of LED circuit boards, previously outsourced to external suppliers. It has also unveiled a wide portfolio of LED products in 2014, including a smart LED bulb called GE Link. Overall, the company is hoping for a turn in its fortunes in 2015.

What could be the overall effect of this restructuring on the lighting market?
IHS believes that the reorganization could turn the leading lighting manufacturers into pure-play lighting companies that can be more focussed on dynamic markets offering greater growth potential.

The restructuring will also allow LED makers to raise capital for further investment, and will likewise let them reduce the hierarchal burden associated with being part of a large conglomerate. This, in turn, could lead to improved margins for the companies—and possibly lower-priced products for consumers

FOUR

Li-Fi: a brighter way to communicate

Light no longer provides illumination alone. LED lighting for indoor positioning, for instance, takes things a step further by sending a basic signal to determine position and help in navigation. Li-Fi, competing with the far more established Wi-Fi, now takes the concept to the next level, using visible LED light for high-speed data transmission of material such as movies, music, or any other form of data.

Alexander Graham Bell, with his invention of the photophone, demonstrated the sending of speech via sunlight in 1880. And while data—such as that in high-resolution movies—riding along a light beam may appear quite futuristic, the technology has already been demonstrated, notably by Harald Haas at the TED Global conference in 2011. It is now in the stage of commercial trials for further development.

A major advantage of the technology is its high speed, with some researchers able to achieve 10 gigabits per second in laboratory conditions. Given these rates, sending a high-definition movie almost instantly is possible. Li-Fi also avoids the overloaded radio spectrum, does not suffer from radio interference or employs no harmful radiation. There are disadvantages, which include the need for additional infrastructure such as modems attached to lights, and the fact that that Li-Fi works only with LED lighting.

Some misconceptions exist about Li-Fi, so the following should be noted: Visible flickering of light is, in fact, not detectable; data transmission still works—albeit at a lower rate—when dimmed; and sunlight interference does not stop the technology from working.

The mass market is one eventual target for proponents of the technology, which also offers benefits in niche applications such as military, aerospace and hospitals. And because the Li-Fi signal cannot pass through walls, data does not leave buildings. This inherent security feature may be attractive to military and government offices hoping to avoid data leaks. For aerospace applications, the lack of interference and radio frequency requirement could enable the high-speed streaming of movies, TV and the Internet throughout a flight. In a hospital, meanwhile, radio waves are used for a variety of important operations, so the transmission of visible light data could remove an interference risk.

LI-Fi as a technology is just starting out. Over the coming years, it will be interesting to see how many commercial projects are announced, and on what scale.

FIVE

Is lighting poised for a quantum leap?

For years organic light-emitting-diode (OLED) lighting has been touted as the next big thing in lighting. It promises all the advantages of LED lighting with the additional benefit of using large, flexible panels that eliminate the need for reflectors or diffusors. Unfortunately, with prices up to 50 times more than those for comparable LED lighting solutions, the few available OLED luminaires available on the market seem more a curiosity than an actual useful product.

The display industry is in some ways a good indicator of the lighting industry in general. Display backlights and solid-state lighting share many requirements in terms of technology, efficiency and color-rendering requirements

Now it appears that OLED displays—which have been waiting in the wings to take over the display market—may be delayed a while still on its way to the top. Samsung recently announced it would launch no more new OLED displays in 2015, instead focusing on "QD-enhanced" LCD displays.

The "QD" stands for quantum dot. In a QD-enhanced display, the backlight is produced by conventional LEDs and filtered through a layer of quantum dots. These tiny semiconductor crystals have the unique property that, when illuminated, emit a very specific color. The color depends on the size of the crystal, and quantum dots can be manufactured to emit any color in the visible spectrum. This allows for superior color gamut, and since less light is lost in the conversion compared to traditional phosphor-based filters, it is also more efficient than conventional LCDs, and even OLED screens.

This use represents only one-half of the potential for quantum dots; the next step will be QD-LEDs. These use quantum dots not just as a filter for an external light source but as the light source itself. Using quantum dots in the light-emitting center of an LED combines the superior color gamut of quantum dots with the efficiency and flexibility of OLEDs.

QD-LEDs are in the early stages of development, but recently some breakthroughs have been achieved in manufacturing, with Princeton University researchers having even 3-D-printed QD-LEDs using an off-the-shelf $10,000 3-D printer. This opens the door for a wide variety of applications, from sensors and solar cells, to integrated displays in contact lenses.

As QD-LEDs still have some challenges to overcome, the market will not likely see vast quantities of commercially available products by 2015 or 2016. However, in the medium to longer term, QD-LEDs could kill off the OLED display market and cause deep disruption to the lighting industry as a whole.

SIX

OLED luminaires, and where to purchase them

While the migration to LED lamps and luminaires is viewed as the chief trend in the lighting industry for the next few years, many in the industry view OLED lighting as the next major development.

OLED lighting offers thin and flexible "panels" that produce light from their surface. The light produced by these panels simulates daylight, which makes it far more natural and relaxing than the light from regular LEDs. However, OLEDs are much more expensive than regular LEDs—in some cases more than 10 times the cost of a comparable traditional luminaire.

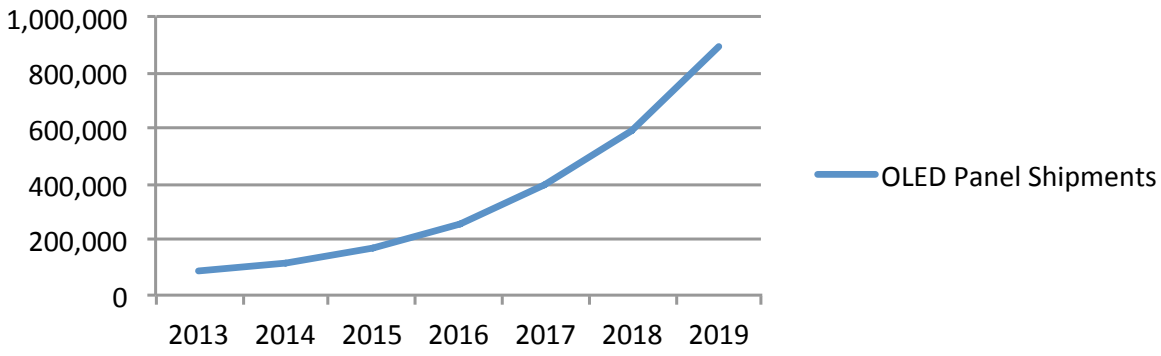
With the high cost for the luminaire itself, OLED so far has been unsuitable for the wider mass market. Historically, OLED luminaires are custom-designed pieces typically purchased through an architect or designer.

But in the last year as the price of OLED panels has decreased, luminaire manufacturers have developed products more suitable to the wider market. American luminaire manufacturer Acuity Brands, for example, has a wide range of OLED luminaires for different applications. While their luminaires are still approximately five times more expensive than a comparable LED luminaire, the technology is beginning to mature.

In a first for the OLED lighting industry, American retailer Home Depot began selling OLED luminaires to the public through its online stores in 2014. This is the first time that OLED luminaires have been available to a mass-market retailer, and it is a big step for the OLED industry, signifying the start of what could possibly be an inflection point in mass-market sales.

OLED lighting still faces many challenges to come. However stylish the products are, the vast majority of consumers will never pay such a high price premium. But with developments in technology, it is expected that the price of OLED panels will fall dramatically in the next seven years. In April 2014, AUO from Taiwan announced it had successfully 3-D printed an OLED display. If this technology starts to be applied to the lighting industry, it could dramatically decrease the cost of manufacturing OLED lighting panels.

Mass-market adoption of OLED lighting is not projected to occur in 2015, but retailers will likely start to offer a premium range of OLED luminaires, which undoubtedly will help create more interest in the overall OLED market.



SEVEN

LED filament bulbs: incandescent beauty with an LED twist

According to the latest data in the IHS Lighting Intelligence Service, consumers have mostly turned to halogen lamps after the ban on incandescent bulbs went into effect. To be sure, cost has played an important role, but the shift is also partly due to looks. Not only do halogen bulbs closely resemble incandescents, many households also dislike the alternative—fluorescent lamps—because fluorescents have a different form factor from the familiar incandescent bulb.

The same is true for LED bulbs, with most LED bulbs on the market today not offering much by way of style. This, however, is about to change.

So-called LED filament lamps combine the benefits of LED lamps with the familiar design of incandescent bulbs beloved by traditionalists. Instead of LED chips arranged on a board or around a corncob, these filaments consist of rows of tiny LEDs on a glass substrate. The glass is covered in yellow phosphor to convert the originally blue light into white, similar to most other LED bulbs.

A number of filaments can be bundled into one bulb for increased brightness, although for the moment filament bulbs top out at around 6 watts, roughly equivalent to 60 watts in an incandescent. And while LED filament bulbs have been around since 2011, they are now starting to match other LED offerings in terms of efficiency, price and color-rendering capabilities.

The LEDs in a filament are wired in series, which means their forward voltage is relatively high at approximately 60 to 80 volts, lowering heat generation and reducing the complexity of the driver circuit. This, in turn, eliminates the need for metal heat sinks and large circuit boards hidden behind a plastic casing.

The result closely mimics the simplicity of incandescent bulbs—a glass housing containing the thin filaments, and the familiar twist or screw cap at the end. As a positive side effect, the filaments provide 360-degree illumination, something conventional LED bulbs struggle with.

Asia and smaller manufacturers have already embraced LED filament bulbs, while the big European and American companies seem hesitant. Ultimately it is up to the consumer to decide if filament bulbs will have their time in the limelight in 2015, but one thing is certain: the last arguments against LED lighting are crumbling quickly.

EIGHT

Packaged LED industry is moving downstream and getting smarter

Some years ago, the senior management at Japanese based chemicals company Nichia suggested it believed that value and leadership in LED lighting would come from quality chips. U.S.-based Cree, meanwhile, stressed that value would increasingly filter down the value chain. Since then, Cree has moved, indeed, in that direction—along with other LED players, such as MLS.

In the last year or two, manufacturers have put increasing emphasis on greater vertical integration, focusing particularly on chip-on-board, modules and light engines. These products have provided an intermediate step in the supply chain between the component LED and a complete lamp or luminaire, and they offer an opportunity for LED manufacturers to diversify and move downstream without going to the extent of producing complete lamps or luminaires.

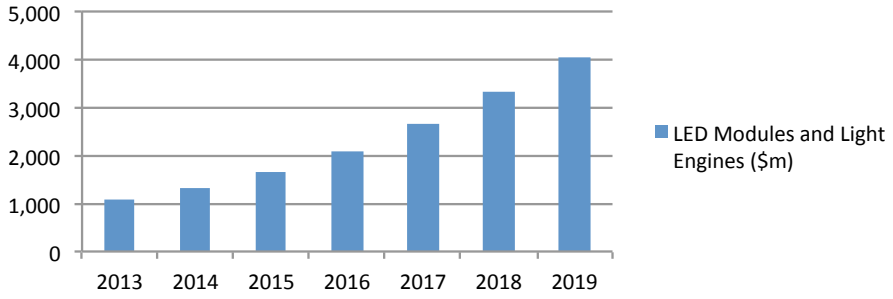
Moving downstream may be an attractive strategy given the low profit margin for component packaged LEDs and the possibility of Chinese vendors taking a greater share of this market in the future. Many companies, such as Bridgelux, Cree, LG Innotek, Lumileds, Samsung, Seoul Semiconductor and Sharp are supplying these products. Lighting companies, such as Philips and Osram, are also suppliers, as are power/module companies like BAG, Harvard, ULT and Xicato.

Modules are LEDs on a printed circuit board without a driver integrated circuit (IC) or other electronics. In comparison, light engines are LEDs on a printed circuit board with a driver IC or other electronics. The combined global market for modules and light engines is estimated at $1.3 billion in 2014. As products become more integrated, growth prospects improve. In the lighting market, IHS projects a compound annual growth rate of 27.3 percent for LED light engines from 2013 to 2019, compared to 11.0 percent for packaged LEDs.

The next generations of light engines are likely to incorporate other features, such as heat sinks and optics. Additionally, IHS sees a significant increase in the incorporation of smart lighting technologies within the engines over the coming years. Smart lighting does more than just turn on or off when someone presses a switch, but instead responds to other factors, such as the time of day, amount of daylight or room occupancy.

Within the smart lighting market there is a trend toward individual luminaire control. One way this can be achieved is by incorporating sensors and controls into the electronics, found at the light engine level. IHS anticipates more engines incorporating smart lighting technologies coming onto the market in 2015, although actual penetration will remain low.

Smart lighting is another way for companies to attempt to add value and improve profit margins. As the LED lighting market moves downstream with modules and light engines, incorporating smart lighting sensors and controls will become, over time, another important part of this trend.



NINE

Is your street light all that it seems?

Street lighting has been around for thousands of years. Starting with the Greeks and Romans who used oil-based lamps to provide security on major streets in cities, the premise today is much the same, providing light to roads and pathways to increase visibility and security at night.

The street lighting system in a city is a classic example of a free-rider problem. Although the public benefits most from the system, there is no way to charge an individual for the use of the street lights, so the government has to pay. This means the street lighting system is a large but necessary drain on the resources of a municipality.

The transition to LED street lights has been well-documented. The energy and maintenance savings significantly help ease the burden of running the street lighting system, but municipalities are always looking for ways of reducing this drain further.

Since current street lighting is what one might call dumb, a major trend in the industry is toward smarter lighting. This is lighting that incorporates sensors and controls to improve functionality of the lamps and luminaires—for example, by turning them on or off, depending on whether someone is in a room. For many years, street lights have incorporated daylight sensors to automatically turn on lights at night, but further savings can be achieved by dimming lights when no one is around.

Current smart lighting applications consist of connecting the luminaires together so that they can be centrally controlled. However, these links can also be used for other things.

For instance, mobile phone companies are currently interested in the communication links to street lights. By incorporating wireless transmitters or mobile phone masts in street light luminaires, communications providers can take advantage of the spare bandwidth in the wired communication links to the luminaires to provide additional coverage in urban areas. With their height, street lights are ideally placed to provide a platform for such services.

There has also been significant interest in how street lights can benefit the users of electric cars. BMW is piloting a scheme in Munich, where car owners can charge their batteries from the power supplies integrated into the street light luminaire.
A major factor in the slow adoption of electric vehicles is the lack of infrastructure, so not only does such a mechanism benefit the electric car industry by expanding the infrastructure, but charging consumers for the use of charging stations can also create revenue to offset the energy and maintenance costs from providing street lighting.

Street lights have been an integral part of civilization for thousands of years, with their function remaining the same since the beginning. But with developments in new technology, as well as the ever-expanding phenomenon of the Internet of Things, the role that street lights play in our world is set to change completely.

TEN

Automotive applications driving optoelectronic components market

The optoelectronics component market has been dominated by a number of applications in recent years. For LEDs, the main applications have been backlighting and solid-state lighting. In the optocoupler and photo relay markets, the focus has been on the industrial sector, while the infrared component and sensor markets are dominated by the consumer and telecommunications sectors. With car ownership increasing in less economically developed regions and vehicles becoming more technologically advanced, the automotive sector is playing an increasingly important role across all the major optoelectronic component product types.

Given the spread of technological advancements in the automotive industry, adoption has increased for infrared components, with a wide range of automotive applications—including headlamps and automatic windscreen wipers—installed in cars now for a number of years. At the Electronica show in November 2014, Osram demonstrated a number of gesture control applications for in-car infotainment and comfort controls. These applications are not currently on sale yet, but the market could start to see some of these applications on the road by 2015.

LEDs and lasers brightening up the road

Penetration of LEDs in headlamp units remains relatively low, with less than 5 percent of car headlamps using LEDs in 2014, according to figures from IHS Automotive. But as popularity, performance and efficiency of headlamps grow, penetration is set to increase to 8 percent in 2015. For their part, LED headlamp unit shipments will increase by 70 percent in 2015, bringing much-needed growth to the global LED market.

Another technology, laser headlights, debuted in 2014 in the BMW i8, followed by Audi in its new R8. This technology is likely to penetrate a wider range of models in 2015, and could start to be a solid revenue earner for the currently limited suppliers of these products.

Advancing battery technology, meanwhile, is helping drive the adoption of electric vehicles, with the increased sales of both hybrid and full electric vehicles also promoting growth in the optocoupler market. In such vehicles, optocouplers are used to isolate the on-board batteries and other high-voltage systems. With shipments of hybrid and electric vehicles growing at a compound annual growth rate of 18 percent through to 2019 and little price erosion projected to occur due to the significant barriers to entry, the optocoupler market will be lucrative in 2015 for manufacturers that can operate in the space.

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