CSP LED LIGHTING MODULES

Market & Technology report - February 2017

CSP LED lighting modules: a potential revolution for the LED industry?

KEY FEATURES OF THE REPORT

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- CSP LED device technology, manufacturing and industry
- CSP LED application landscape
- CSP LED module pros and cons, and impact on supply/value chain
- CSP LED module design: thermal management, optical design, power supply and driver

OBJECTIVES OF THE REPORT

Objectives are to understand:

CSP LED technology:

- Differences from other packages
- Impact on manufacturing processes
- Potential for cost reduction

Changes in system design and integration rules:

- Impact on optical design
- Impact on thermal management
- Impact on electrical management

Performances in applications:

- Positioning of CSP LEDs compared to mid-power, high-power LEDs and COB LED modules
- Opportunities for CSP LEDs in applications

Competitive landscape and supply chain:

- Identify key players
- Impact on the LED supply chain

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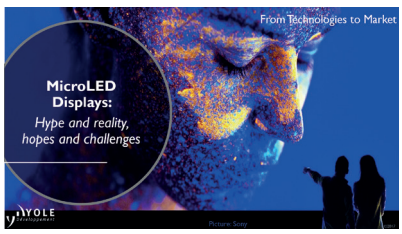

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CSP LEDS: A PROMISING SOLUTION WITH CHALLENGES TO OVERCOME

Chip-scale packages (CSPs) are new to the LED industry, but are the mainstay of the traditional semiconductor industry, where they improve reliability, thermal management and enable smaller packages.

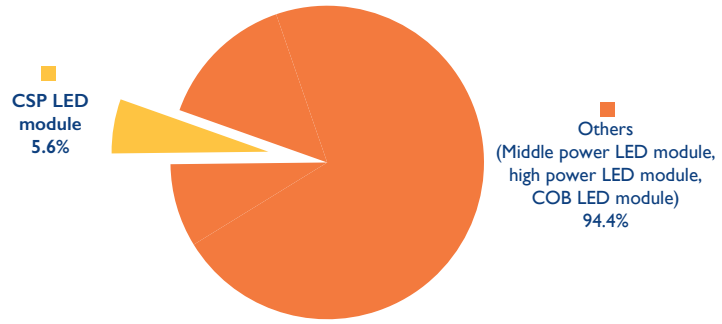
CSP LEDs can be less than a tenth of the size of high and middle power LEDs, increasing power density and simplifying integration into final products. This new architecture can also lower thermal resistance, improve reliability and widen viewing angles compared to other traditional packages.

However, there are also several challenges to overcome at the device manufacturing and module integration levels. These include color uniformity, chemical stability, given there is little to no sealing off from the external environment, and control of optical properties like the radiation pattern.

In this context, Yole Développement estimates that CSP LED modules represented less than 1% of the LED module business in 2016. However, with strong potential in multiple applications and the lighting industry getting experience with integrating such technology, we forecast a market share of nearly 6% by 2021.

This report provides a comprehensive analysis of CSP LED devices, with analyses including: chip and package technology, manufacturing processes, related costs/prices, industry and market trends. The report details deeply analyses CSP LED lighting module design, with focuses including: optical design, thermal and electrical management and precautions for CSP LED integration.

LED lighting module market revenue in 2021
Breakdown by module technology in US$



A CSP LED market size multiplied by more than 3 since 2016

(Yole Développement, February 2017)

AFTER SMARTPHONES AND TVS, A POTENTIAL REVOLUTION IN GENERAL AND AUTOMOTIVE LIGHTING APPLICATIONS?

CSP LEDs add value through power density offered from a small surface. The first targeted application was smartphone flashes. As smartphones get thinner and add functions, so too must integrated components/modules.

The small form factor and wide beam angle of CSP LEDs have also driven their use in TV backlighting units. Wide beam angles mean the pitch between LEDs can be larger, reducing the number of devices needed and in turn lowering backlight cost.

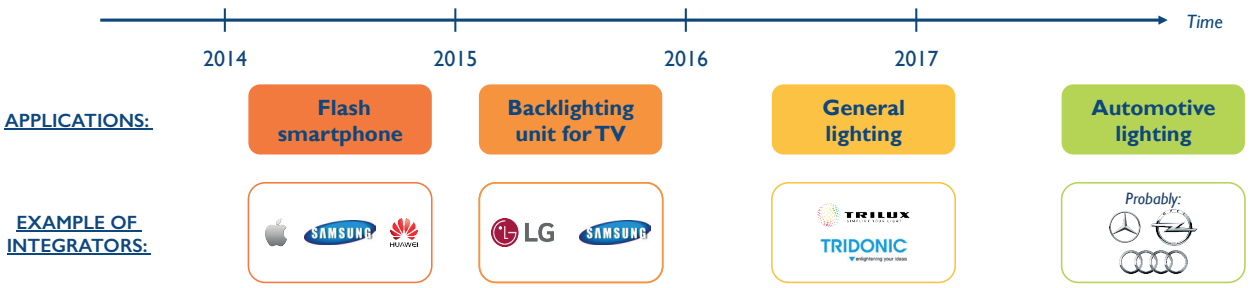
But CSP LEDs are also a means to develop new functions in lighting products. Some general lighting applications are likely to adopt these light sources to reduce the cost of the lamp/luminaire. Their small size enables LED clusters, similar to chip-on-board (COB) LED modules but with more functionality. CSP LED clusters promise tunable white, human centric light (HCL), intended to promote a person's well-being, mood and health, and others smart lighting functions.

Last but not least, high luminance and uniformity will mean CSP LEDs enter automotive headlamp applications, which requires high intensity and beam shape control. New developments in

matrix headlamps will include CSP LEDs to increase matrix resolution, enhance driver vision and improve Advanced Front Light Systems (AFLS) in combination with cameras.

In this report, Yole Développement maps the CSP LED application landscape. It analyses CSP LED lighting module performance in general lighting applications, identifying opportunities, describing case studies, and comparing positioning against other module technologies.

CSP LED application landscape



(Yole Développement, February 2017)

SIMPLIFIED MANUFACTURING PROCESS IMPACTS THE SUPPLY/VALUE CHAIN

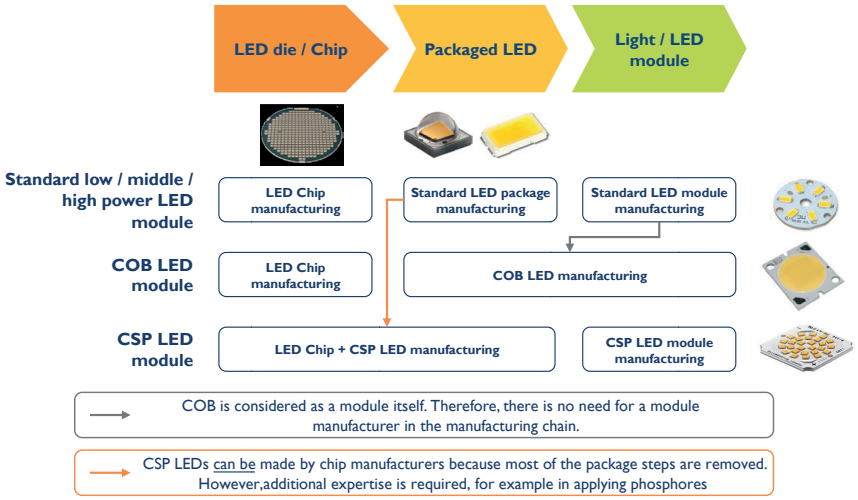
CSP LED technology eliminates some package assembly and die attach stages. This is likely to benefit to LED chip manufacturers, who can develop packages and supply them directly to LED module manufacturers more easily, bypassing their traditional customers, and so increasing their profits. Vertically integrated LED manufacturers can also decrease their packaging costs. However, adopting the technology requires development of new expertise, modifying the traditional packaging landscape. For example, phosphor and encapsulant deposition processes will move from dispensing to phosphor sheet/film deposition or molding. This evolution affects equipment and material suppliers, who have to develop new solutions.

Operationally, Lumileds was the first company to commercialize LEDs in CSP format in 2013. The company was rapidly followed by several other players, mostly Taiwanese. But some others, like Osram, still have doubts about the necessity of such technology, and instead are positioned toward traditional middle and high power LEDs, including COBs.

This debate is also relevant at the LED module level, where CSPs cause some difficulties. For example, during PCB design, special care should be given to copper traces and solder masks for optimum performance. Some critical properties, like their small soldering surfaces and sideways light emission, may impact module integration. And while the benefits of CSP LEDs are not yet clear for them, they question the real opportunity of this solution.

This report provides insights into the changes in manufacturing and integration processes CSP LEDs bring, and potential consequences on the supply/value chain. Additionally, it analyses real opportunities for such technologies based on simulations and case studies.

Comparison between standard, COB and CSP LED module manufacturing chain



(Yole Développement, February 2017)

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YOLE DÉVELOPPEMENT

Pars MUKISH holds a master's degree in materials science and polymers from ITECH in France and a master's degree in innovation and technology management from EM Lyon in France. Since 2015, Mukish has taken on responsibility for developing LED, OLED and sapphire activities as Business Unit Manager at Yole Développement. Previously, he worked as Marketing Analyst and Techno-Economic Analyst for several years at the French Research Center, CEA.

Pierrick BOULAY works as Market and Technology Analyst in the fields of LED, OLED and lighting systems, doing technical, economic and marketing analysis at Yole Développement, the "More than Moore" market research and strategy consulting company. He has experience in both LED lighting, including general lighting and automotive lighting, and OLED lighting. In the past, he mostly worked in R&D departments for LED lighting applications. Pierrick holds a master degree in Electronics from ESEO in France.

PISEO

Dr Olivier ANDRIEU is R&D Project Director and Mechatronic and LED System Architect at PISEO. He is working in collaboration with Yole Développement's team to perform comprehensive technical analyses of innovative LED-based optical systems and markets. His expertise is based on the development of disruptive solutions taking into account mechanical, electronic, optic and thermal issues to achieve application requirements. Previously, Dr Andrieu worked for EFI Automotive as head of innovation and more recently for Philips Lighting where he developed and implemented numerous LED lighting solutions on a global level.

Joel THOME is the General Manager and Senior Research and Innovation Consultant at PISEO. In collaboration with Yole Développement's team, Thome performs numerous technical and market analyses focusing on LED solutions, in addition to developing innovative optical solutions with PISEO's R&D team. With a master's degree in mechanical engineering, Thome has worked in the lighting industry for more than 25 years. After beginning his career at Philips Lighting, he has recently held various global business, marketing and R&D senior management positions. During this period he developed strong expertise in lighting controls, LED technology and innovation processes including strategic roadmaps and project portfolio management. Today, Thome is also the administrator of the GIL-Syndicat du Luminaire trade union organisation and the Cluster Lumière association.

Find more details about this report here:

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Founded in 1998, Yole Développement has grown to become a group of companies providing marketing, technology and strategy consulting, media and corporate finance services. With a strong focus on emerging applications using silicon and/or micro manufacturing, the Yole Développement group has expanded to include more than 50 collaborators worldwide covering MEMS, Compound Semiconductors, LED, Displays, Image Sensors, Optoelectronics, Microfluidics & Medical, Advanced Packaging, Manufacturing, Nanomaterials, Power Electronics and Batteries & Energy Management. The "More than Moore" company Yole and its partners System Plus Consulting, Blumorpho, KnowMade and PISEO support industrial companies, investors and R&D organizations worldwide to help them understand markets and follow technology trends to develop their business.

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- Report Business: Fayçal Khamassi (khamassi@yole.fr)
- Press relations: Sandrine Leroy (leroy@yole.fr)

ABOUT PISEO

A unique innovation platform dedicated to smart LED based optical systems. PISEO owns high skilled engineers and cutting edge characterization equipment, all situated in a single location. The team, mainly issued from an industrial global leader, delivers a whole set of services to the industry throughout the entire product life cycle. Therefore, PISEO runs projects from applied research up to product recycling, including market analysis, technology scouting, strategic planning and industrial design.

CONTACTS

More info on www.piseo.fr
Press contact: Joël Thomé, PISEO General Manager (thome.joel@piseo.fr)

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