

Sensing is life

amun OSRAM

Enhancing Safety at Night

by “Visualizing the Unseen”



People are the center of safety

Michael Godwin & Joe Jablonski
September 22, 2021

Enhancing Safety at Night with LED

by Visualizing the Unseen

ams OSRAM Company at Glance

Forward Illumination with OSLON Portfolio

LED Selection for Forward Lighting

Integrated Monolithic LED ; EVIYOS 2.0

Summary : Forward Illumination & Visualization

Vision and mission for ams-OSRAM

Sensing is Life : Building Blocks

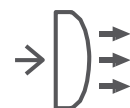
>5.5 bn USD 2020*
5,500+ Engineers
~30,000 Employees
40+ R&D locations
15,000+ Patents

Emitters



- **LEDs**
- **µLED (Micro LED)**
- Lidar: EEL/VCSELs
- Lamps

Optical components & micro-modules



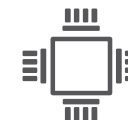
- Optical elements: Lenses, light guides, DOEs
- Micro-optical packaging
- Optical modules

Detectors



- Light sensors
- Bio-sensors
- Image sensors

Integrated circuits & algorithms



- Emitter driver ICs
- Sensor interfaces
- Sensor processors (incl. algorithms)

Micro-Optical Solutions & Lamps

Sensing



Illumination



Visualization







Illumination

Visualization



Slim
Forward
Lighting

Std HB & LB
Forward

Adaptive Driving
Beam





OSRAM
High Resolution
Projection

Styling Forward Lighting
Design

***Cost effective LED forward lighting will increase adoption
and enhance nighttime safety.***

Forward Lighting Systems to Enhance Safety

An LED for Every Application



OSLON Black Flat S&X
OSLON Compact
OSLON Submount

Standard - Low Beam / High Beam





OSLON Boost HM
OSLON Compact PL

Slim Headlamp Designs




OSLON Compact PL
OSLON Compact PM

Matrix Beam - Adaptive Driving Beam



OSLON Boost HX- DLP
EVIYOS 2.0

High Resolution Projection Systems



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Forward Illumination with OSLON Portfolio

LED Selection for Forward Lighting (Lumens/ Luminance)

Integrated Monolithic LED ; EVIYOS 2.0

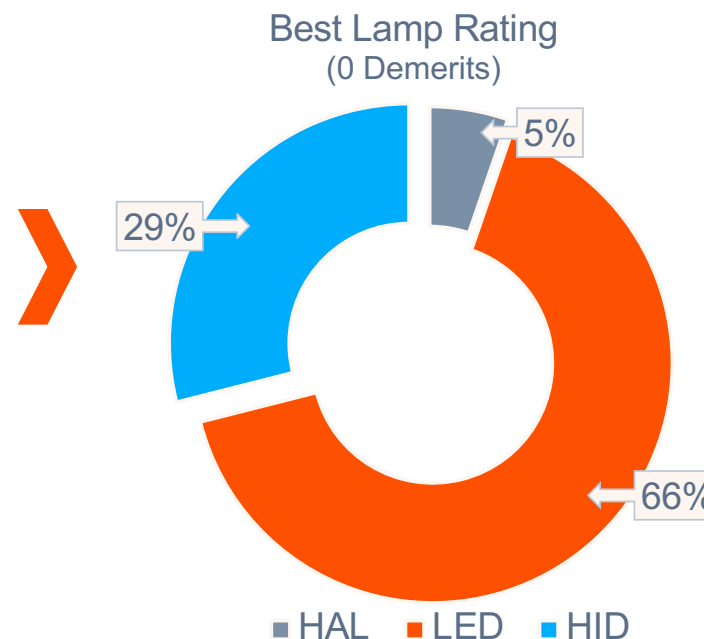
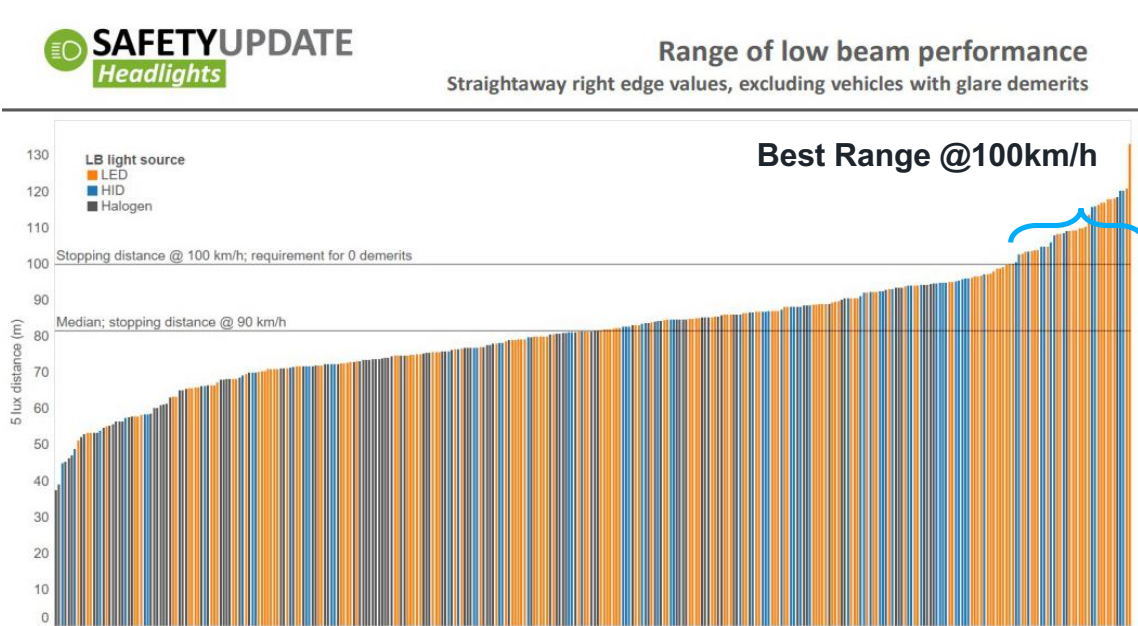
Summary: Forward Illumination & Visualization

Safety Impact with Low Beam Stopping Distance (0 Demerits)

LED Light Source Represents 66% of Best Vehicle Tested



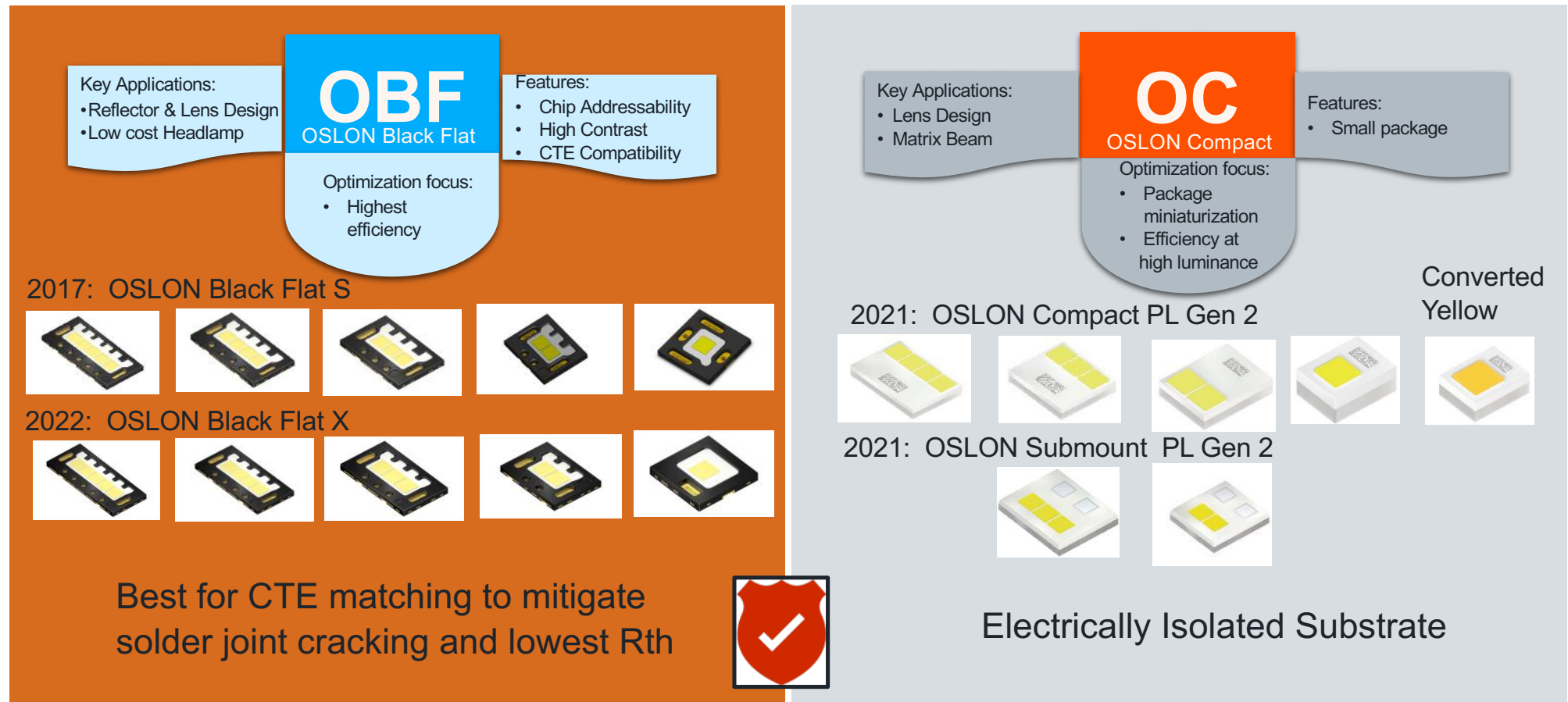
Increasing lamp performance with economical LED solutions will enhance nighttime safety across all platforms



Protocol and rationale documents are online <http://www.iihs.org/iihs/ratings/technical-information/technical-protocols>
2018 CARHS Safety Report Vehicle

Differentiation of OSLO Black Flat and OSLO Compact

High Performance Engineered Products



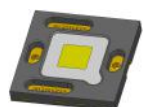
High Power White: Best-in-class Brightness

Double-digit Performance Increase Every 3 Years



- Production
- Development
- Concept

■ 2019 to 2021 ■ 2021 to 2023



11%

23%



11%

13%



15%

18%

OSLON Black Flat

2019	2021	2023
350 lm	390 lm	480lm



- Standard LB/HB ("Halogen replacement")
- Heat-sink-less Headlamp

OSLON Compact

2019	2021	2023
350 lm	390 lm	440 lm



- Matrix systems <40 pixels
- Entry level ADB
- Design driven LB/HB

OSLON Submount

2019	2021	2023
680 lm	780 lm	920 lm



- Standard LB/HB
- LED Headlamp

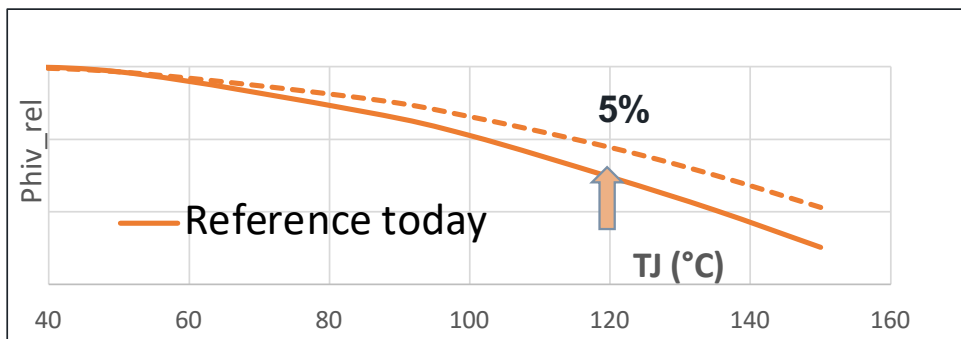
*All brightness values are typical for the shown product.

LED Efficiency Enables Economic Headlamp Systems

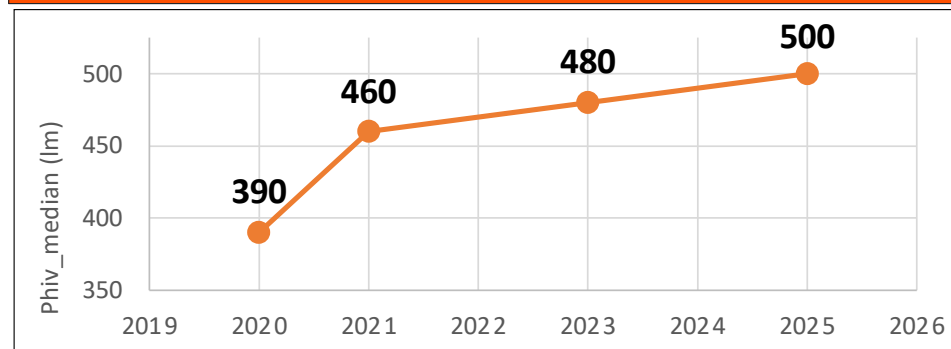


Latest Technology Delivers More Luminous Flux & Higher Luminance

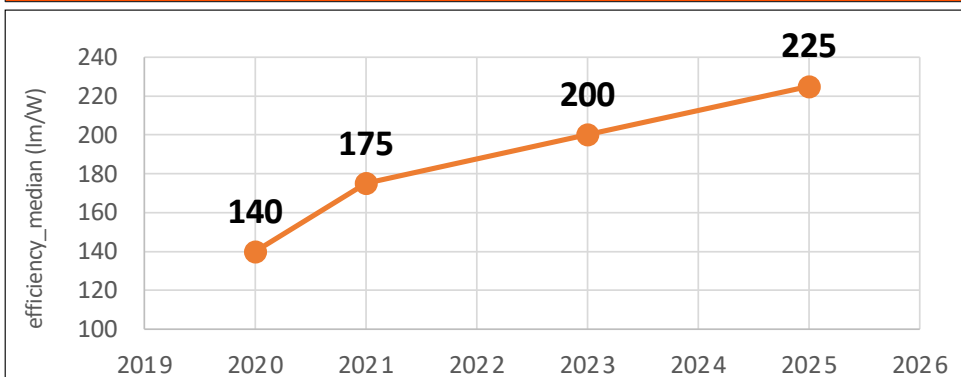
Hot Cold Performance Tj 120C Optimization



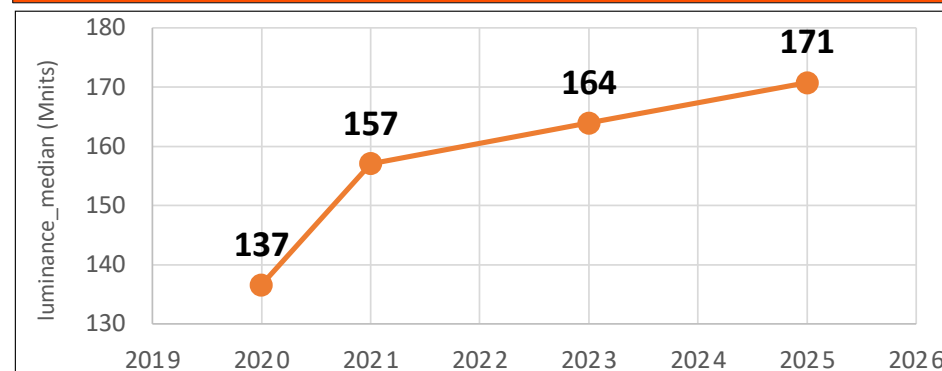
Typical Luminous Flux @1A and @25°C



Typical Efficiency for 300lm/ Chip



Typical Luminance @1.5A and @25°C



Source : Rainer Huber, ams OSRAM

Dynamic Low Resolution Forward Lighting

OSLON Compact PL : Ideal for ADB and Slim HL Design



Brightness:
390lm/ chip*

*Typical value per mm² chip size at 1A

Key Product Trends:

- Ceramic based package technology.
- High efficiency.
- High luminance.
- Compatible with electrically isolated substrate.

Key Application Trends:

- Adaptive driving beam (ADB).
- Standard light modules.
- Front turn indicator.
- Brightness enhancements.
- Increased resolution.

Converted Color				
KW CELNM2.TK 1 -Chip	KW2 CFLNM2.TK 2- Chip	KW3 CGLNM2.TK 3- Chip	KW4 CHLNM2.TK 4- Chip	KY CELNM2.FY1 converted yellow 1- Chip
InGaN Technology				



Illumination Matrix Beam LED Solution

OSLON Compact PM : Ideal Mid Power ~100pixel Matrix Systems



Brightness:
240lm/ chip*

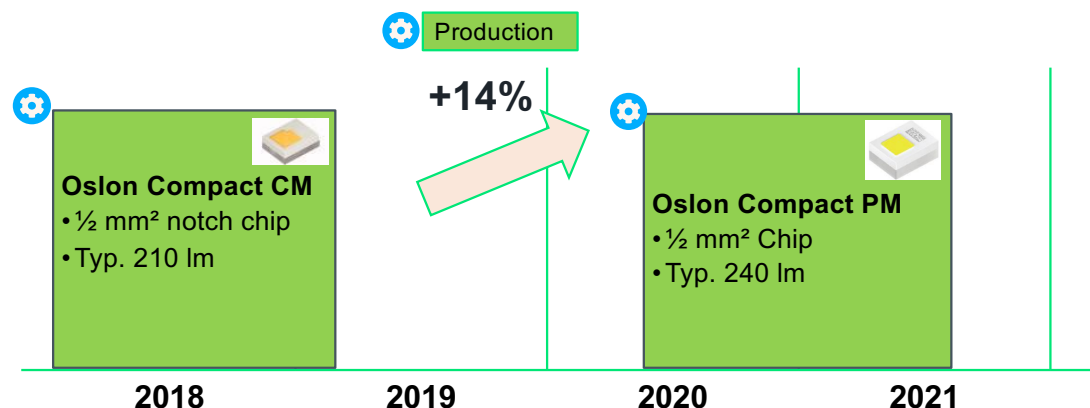
*Typical 1/2mm² chip size at 700mA

Key Product Features:

- High efficiency LED Technology.
- Miniaturized package (½ mm² chip).
- Latest notch-less chip technology for easier optical design.
- Low Z-tolerances (+/-35µm).

Key Application Trends:

- Ideal for projector & reflector ADB headlamp design ~ 100 pixels Matrix ADB.
- Super compact ½ mm² SMT ceramic based package.
- Electrically isolated thermal pad.
- Improved mechanical stability for manufacturable processing.



Static Function Forward Lighting

OSLON Black Flat X : Ideal for Standard High Beam and Low Beam



New

**Brightness:
460lm/ chip***

*Typical value per mm² chip size at 1A

Key Product Feature

- Addressable functionality for ADB.
- Highest brightness & efficiency offers the possibility to reduce heat sink-less design.
- Reliable leadframe based package technology.
- Very High contrast >1:200 due to black package material and TiO₂ casting.

Key Application Trends:

- Ideal for projector & reflector headlamp designs.
- Homogeneous color over angle radiation with innovative processing.
- A new solder pad layout enables enhanced reliability and superior thermal management.
- Best thermal management reduces thermal cost burden.

Converted Color				
KW HHL631.TK 1 -Chip	KW2 HML631.TK 2- Chip	KW3 HNL631.TK 3- Chip	KW4 HPL631.TK 4- Chip	KW5 HQL631.TK 5- Chip
InGaN Technology				

Notch-less chip technology for easier optical design

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Forward Illumination with OSLON Portfolio





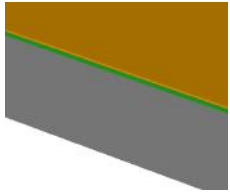
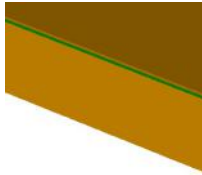
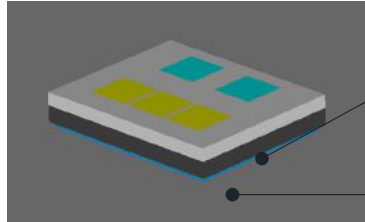
LED Selection for Forward Lighting

Integrated Monolithic LED ; EVIYOS 2.0

Summary; Forward Illumination & Visualization

Differences in the Forward Lighting Portfolio

An Optimized Package for Every System

Leadframe & Epoxy Packaging		Ceramic Packaging	
Standard Surface Mount Technology		Submount Technology	
OSLON Black Flat S KW HJL531.TE	OSLON Black Flat X KW3 HNL631.TK	OSLON Compact PL 2 KW3 CGLNM2.TK	OSLON Submount PL KW C3L5L2.TK
			
V_F 9.0 V Φ_V 1170 lm	V_F 9.3 V Φ_V 1380 lm	V_F 9.3 V Φ_V 1170 lm	V_F 9.3 V Φ_V 1170 lm
 <p>Enhanced IMS – Al MCPCB</p> <ul style="list-style-type: none"> • 35 μm Cu Layer • 38 μm Dielectric (3 $\text{Wm}^{-1}\text{K}^{-1}$) • 1.5 mm Aluminum Base 	 <p>FR4 laminated on Cu plate with μVia</p> <ul style="list-style-type: none"> • 35 μm Cu Layer • 75 μm Dielectric (0.6 $\text{Wm}^{-1}\text{K}^{-1}$) • 1 mm Cu base 	 <p>Adhesive</p> <ul style="list-style-type: none"> • Thickness 50 μm • 6.9 $\text{Wm}^{-1}\text{K}^{-1}$ <p>Heat Sink</p>	

Differences in the Forward Lighting Portfolio

Differing Performance Options with Optimized Substrates



Component	typ. $\Phi_V @ 25^\circ\text{C}$	MCPCB			Other Substrate/mounting			
		P_{heat}	max. T_J	$\Phi_V @ T_J$	P_{heat}	max. T_J	$\Phi_V @ T_J$	Substrate
OSLON Black Flat S KW HJL531.TE	1170 lm	5.95 W	139°C	894 lm				
OSLON Black Flat X KW3 HNL631.TK	1380 lm	5.67 W	134°C	1115 lm				
OSLON Compact PL Gen 2 KW3 CGLNM2.TK	1170 lm	5.98 W	140°C	928 lm	5.98 W	133°C	953 lm	FR4 on Cu with μVia
OSLON Submount PL KW C3L5L2.TK	1170 lm				5.98 W	134°C	951 lm	glued to heat sink

Boundary Conditions

- Ambient Temperature $T_{\text{amb}} = 85^\circ\text{C}$
- $I_f = 1 \text{ A}$
- Still Air
- Conjugate Heat Transfer
- Steady State

What to do with More Efficient LEDs?

Heatsinkless Headlamp Concept

Turn Indicator
1 LED
148 x 45

Turn Indicator
 $T_{\text{junction}} = 110^{\circ}\text{C}$
 $P_{\text{heat}} = 1.41\text{ W}$

Outstanding Features

- Low thermal resistance with chip on copper
- CTE matching PCBs and IMS
- High optical flux 422/845 lm @ 1.0 A
- High luminance 130 Mcd/m² @ 1.0 A
- Optimized low voltage 2.93 V @ 0.7 A
- Efficacy 150 lm/W @ 0.7 A
- High Package Contrast >>250:1

DRL
 $T_{\text{junction}} = 106^{\circ}\text{C}$
 $P_{\text{heat}} = 1.56\text{ W}$

• Transmission Cover glass: 85%
• Reflectivity of reflectors: 85%
High Beam
 $T_{\text{junction}} = 139^{\circ}\text{C}$
 $P_{\text{heat}} = 3.03\text{ W}$

H
98



2 LED

Low Beam 2
 $T_{\text{junction}} = 145^{\circ}\text{C}$
 $P_{\text{heat}} = 3.03\text{ W}$

Low Beam 2 LED
72 x 43

Low Beam 1
 $T_{\text{junction}} = 140^{\circ}\text{C}$
 $P_{\text{heat}} = 3.03\text{ W}$

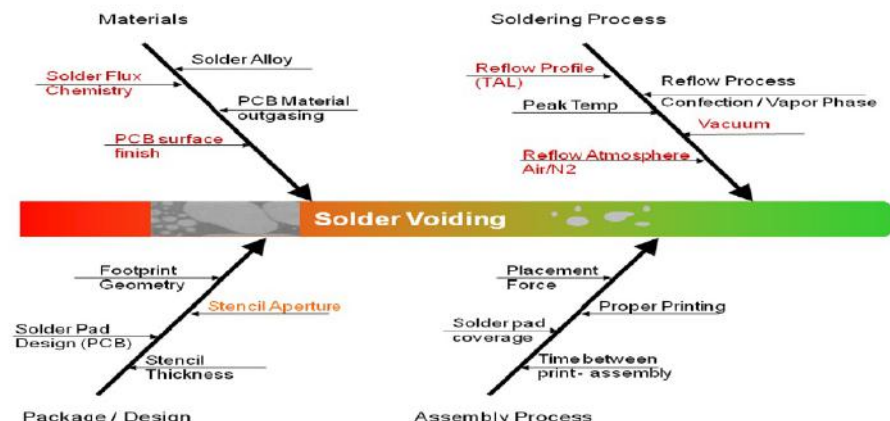
Considerations for Higher Reliability to Keep the Light On

Solder Joint Reliability Through Material Selection

CTE Tradeoff of Materials

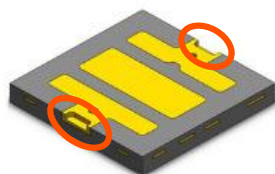
	Coefficient of Thermal Expansion (CTE)	Young's Modulus	Cost
Cu Lead-frame (LED)	16 ppm/K	128 GPa	Low
Aluminum (MCPCB)	24 ppm/K	70 GPa	Low
FR4 (PCB)	17 ppm/K	40 GPa	Low
Cu (MCPCB)	16 ppm/K	128 GPa	High
Ceramic (LED)	4 ppm/K	345 GPa	High

Understanding the influences on Voiding



Higher Reliability with component design Features

**OSLON Black Flat Family
Solder Inspection Chamfer**



**Better Self Centering
AOI Inspection Capability**

Higher Reliability with Component Qualification

- AEC-Q102 and MCM Annex
- USCAR 33
- ZVEI
- Continuous Qualification Testing

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Forward Illumination with OSLON Portfolio

LED Selection for Forward Lighting

Integrated Monolithic LED ; EVIYOS 2.0

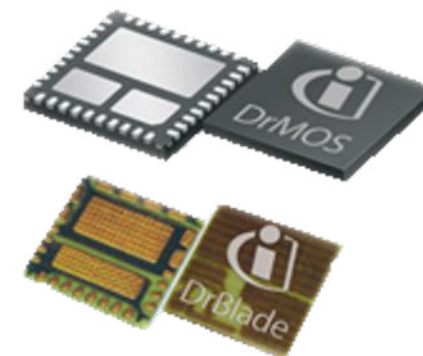
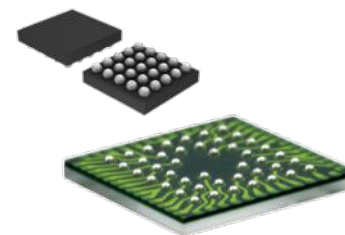
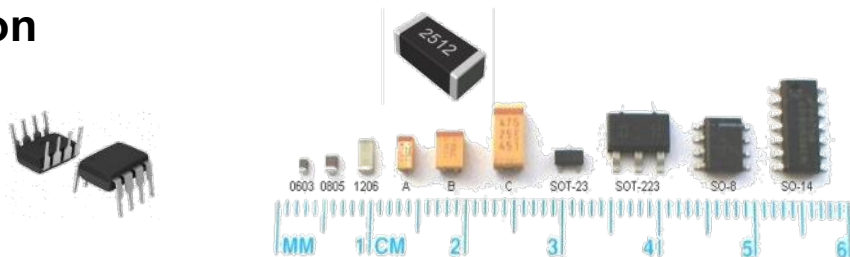
Summary: Forward Illumination & Visualization

Evolution of Integrated Monolithic LED; EVIYOS

Leading with Innovation, Manufacturability & Simplified Solutions



Silicon



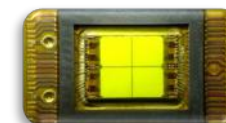
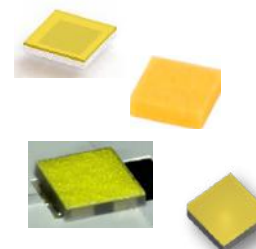
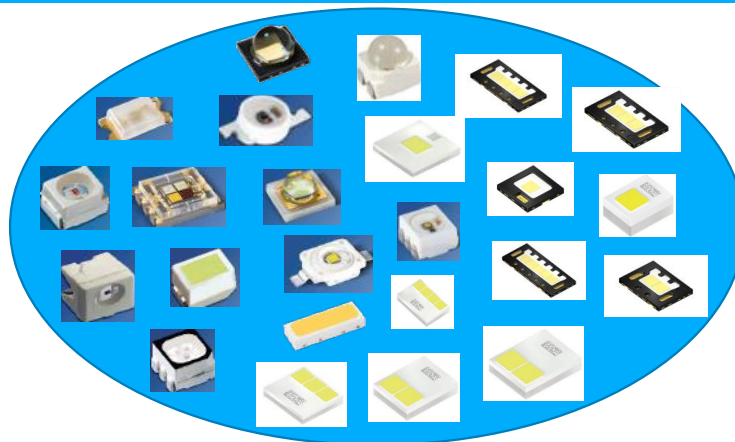
Through Hole

SMT

Flip-Chip, BGA & CSP

Monolithic & Integrated

LED



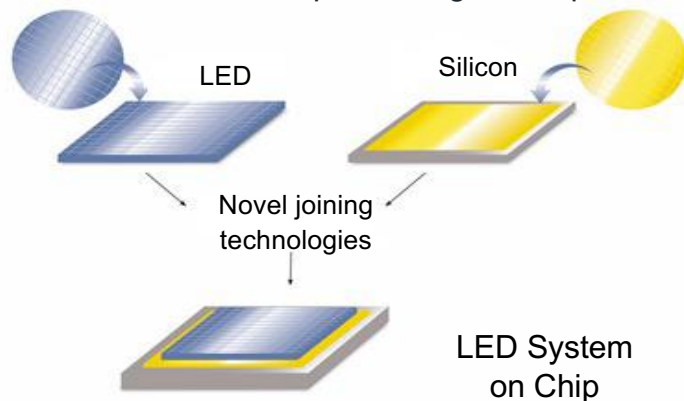
Visualization & Illumination

Visualization with Monolithic Pixelated LED

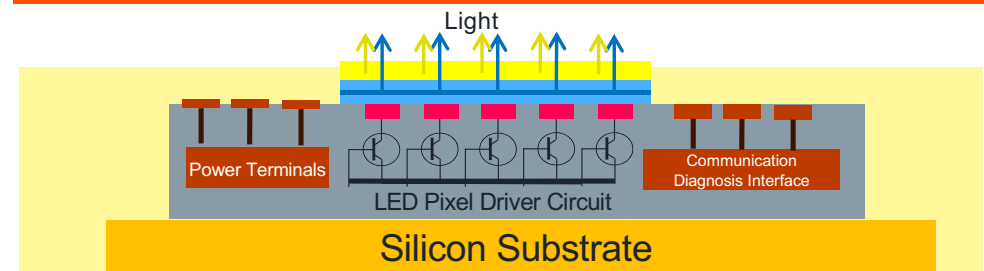
EVIYOS® 2.0 Device



EVIYOS is produced with precision lithography and wafer to wafer processing techniques



EVIYOS 2.0 Cross Section:

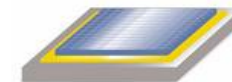


Features:

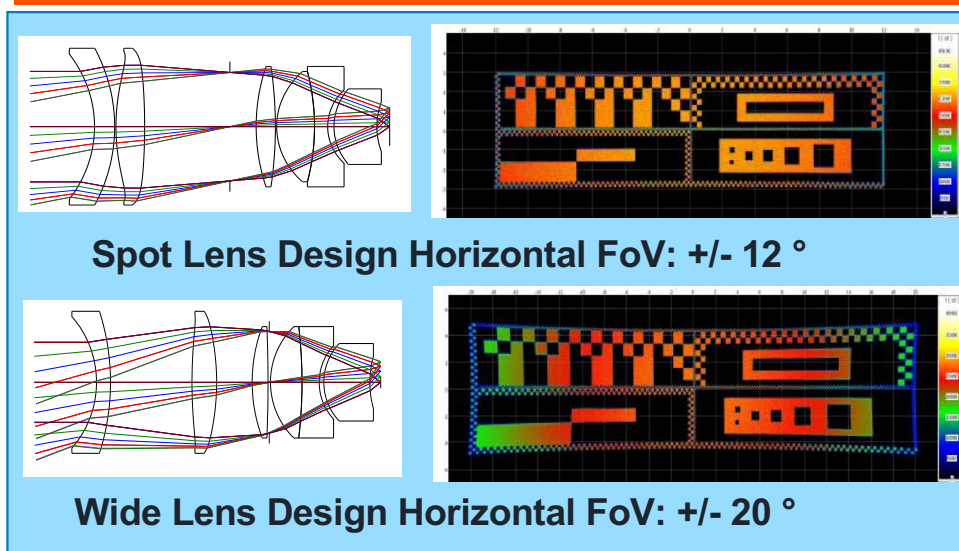
- 40 mm² emission area with 40 µm pixel pitch ✓
- High contrast >> 240:1
- Aspect ratio 1:4 , 1:3 ✓
- 25,600 pixels / EVIYOS ✓
- Integrated self-diagnostics with FPGA or ASIC ✓
- Efficient power utilization ✓
- **SOP: 2023** ✓

Visualization Architecture

Dynamic Pixel Resolution “on the Road” Required Engineered Precision

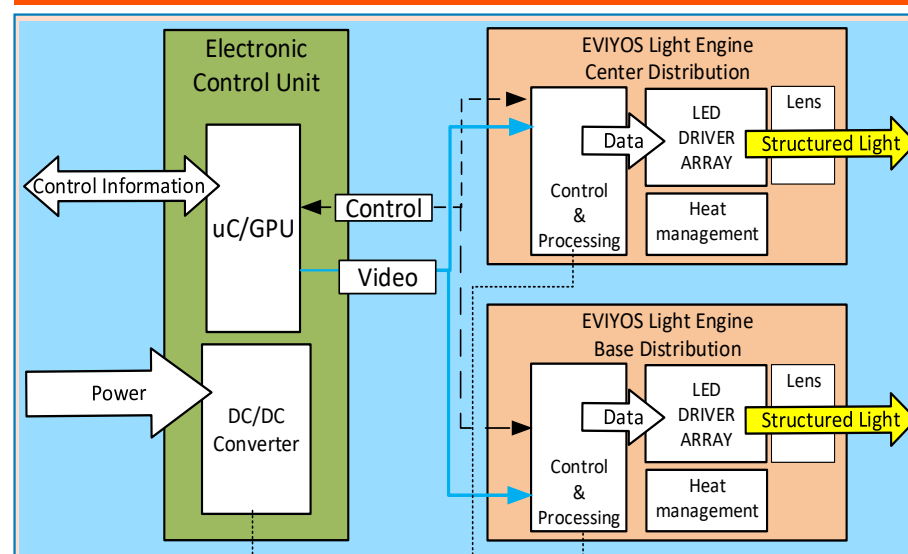


Optical System Architecture



- System length: <100mm
- Diameter last lens: < 50mm
- Numerical Aperture ~ 0.6
- # of lenses <=6

Active Pixel-LED System Architecture

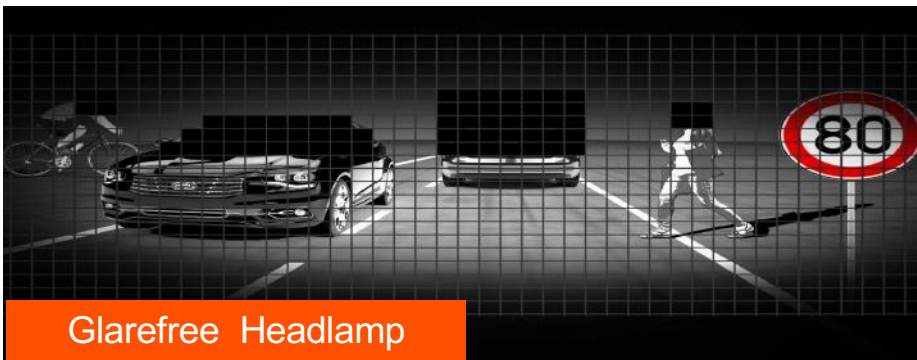


Enhanced Safety with Illumination & Visualization

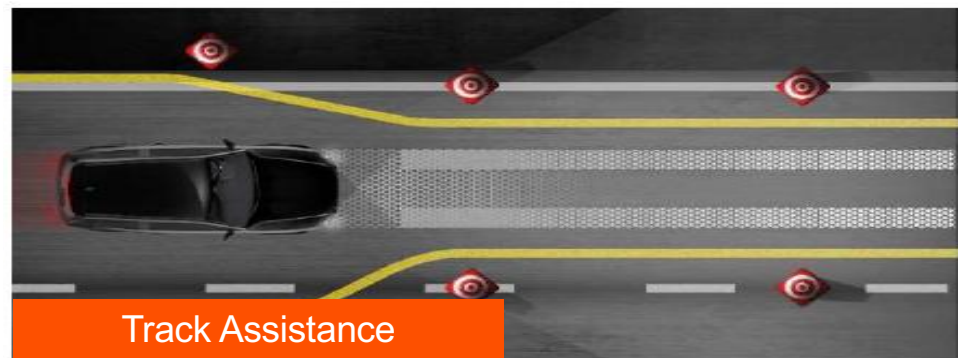
EVIYOS 2.0 Flexibility



Dynamic Illumination w/ ADB functionality



Visualization Communication & Symbols



Projected Visualization will Enhance Pedestrian Safety

Convergence of Forward Lighting and ADAS



Safety Facts:

- Pedestrian fatalities rose 12.9% from 5,494 in 2015 to 6,205 people in 2019
- NHTSA reports that 17 pedestrians die every day in 2019

Visualization with EVIYOS 2.0

- Sensing and communication of critical warning messages that enhance safety.
- Dynamic content with perceived high importance for safety.
- Optical projection without color or image aberrations and distortions.
- High quality image resolution with realistic symbology.

Note : Projected symbols discussion is underway with GTB Committee to avoid confusion with traffic signs and municipalities.



Enhancing Safety at Night with LED

by Visualizing the Unseen

ams OSRAM Company at Glance

Forward Illumination with OSLON Portfolio

LED Selection for Forward Lighting

Integrated Monolithic LED ; EVIYOS 2.0

Summary ; Forward Illumination & Visualization

Summary: Night-time Driving Safety is Realized

Best in Class LEDs to.... Visualize the Unseen

- Lead-frame based LED offer the most economical forward lighting solution with best thermal resistance and system performance.
- OSOLON Black Flat X is best in class for democratization of halogen replacement with efficiency & brightness.
- OSOLON Compact ceramic base LEDs are ideal for slim lamps and matrix LEDs from 40 - 100 pixels with electrical isolation.
- Visualization requires higher resolution, higher contrast, data management and higher luminance to project impactful images.
- Monolithic EVIYOS 2.0 light source can deliver for both ***illumination and visualization.***



OSOLON Black Flat X

Best for economical heat sink-less forward lighting



OSOLON Compact PL

Best with Fr4 µvia substrates



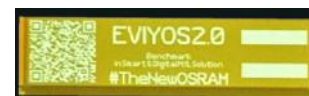
OSOLON Boost PM

Best for 40 –100 pixel ADB forward lighting (1/2mm²)



OSOLON Submount PL

Excellent performance for submount manufacturing



EVIYOS 2.0

1st monolithic LED with 25,600 addressable pixels

Sensing is life



Thank you

Special thanks to ams OSRAM Automotive systems solutions engineering and marketing team members