Application Note No. AN008

OSRAM
Opto Semiconductors

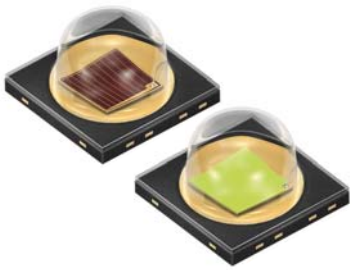
Reliability of the OSLON® Black Series family

Application Note

Valid for:
LxW H9GP
Lx H9GP

Abstract

This application note provides an overview of the performance of the OSLON® Black Series product family along with a summary of the most important application-relevant LED data in regard to its effects on the products' lifetime.



Note in general that in spite of the very high levels of reliability of the LEDs, great overall or system reliability can only be achieved by considering all factors and parameters (refer also to the application note "AN006 Reliability and Lifetime of LEDs").

Users can possibly influence the reliability of LEDs mainly by their selected operating conditions, by considering the production information and – in the case of high-performance LEDs, such as the OSLON® Black Series product family – by providing a competent thermal management system.

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A. OSLON® Black Series family

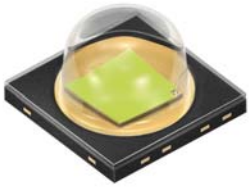
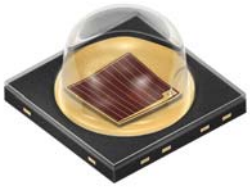
The OSLON® Black Series family was developed particularly for applications that require maximum luminous flux with little consumption of space. The package also makes the series predestined for applications that experience high temperature fluctuations because very good solder point reliability can be expected, particularly in combination with insulated metal substrate boards (IMS PCBs).

As a consequence, the product group has been qualified on the basis of the AEC-Q101-REV-C guideline "Stress Test Qualification for Automotive Grade Discrete Semiconductors".

With their performance and design, the OSLON® Black Series LEDs are suited to a wide variety of uses in light and illumination technology, from automotive applications to general lighting purposes. Due to their very compact design, the LEDs are also particularly suitable for combining and operating in clusters.

Table 1 shows an overview of the OSLON® Black Series group with the available color and white variations.

Table 1: Overview of the OSLON® Black Series group

LxW H9GP (ThinGaN)	**Lx H9GP** (Thinfilm)
	
Ultra White, **C**olor on Demand White	**A**mer, **R**ed, **Y**ellow

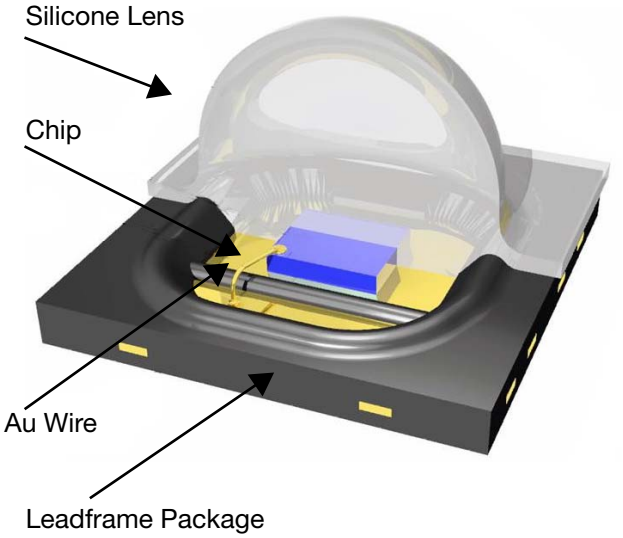
Designed for high-volume production, the LEDs can be processed with all typical SMT mounting technologies and secured by means of leadfree reflow soldering.

As with all other LEDs from OSRAM Opto Semiconductors, the OSLON® Black Series also complies with the applicable RoHS specifications (EU and China) and does not contain any lead or other hazardous substances.

B. Construction and degradation mechanisms of the OSLON® Black Series

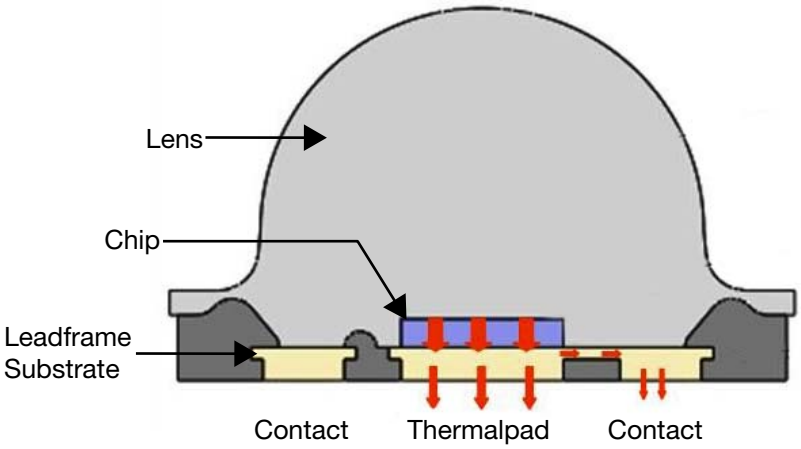
The OSLON® Black Series is designed according to a concept for packages that comprise a leadframe-based plastic base and a hard silicon cast as a lens (see Figure 1).

Figure 1: Construction of the OSLON® Black Series



The integrated metallic leadframe has the advantage that a very low overall thermal resistance and excellent durability, particularly on insulated metal substrate boards (IMS PCBs), can be achieved. Figure 2 shows the primary heat flow in the OSLON® Black Series. Since the heating pad is electrically connected to the anode, the application must ensure that the solder point of the heating pad is electrically insulated from the other contacts.

Figure 2: Primary heat flow in the OSLON® Black Series



A major factor affecting the lifetime of an OSLON® Black Series LED is the temperature of the light-emitting layer (Tj) at which the LED is operated in the application. The lower the junction temperature Tj, the higher the expected lifetime of the LED. It is therefore important that a good thermal management system is implemented not only within the LED, but also by the system in the application.

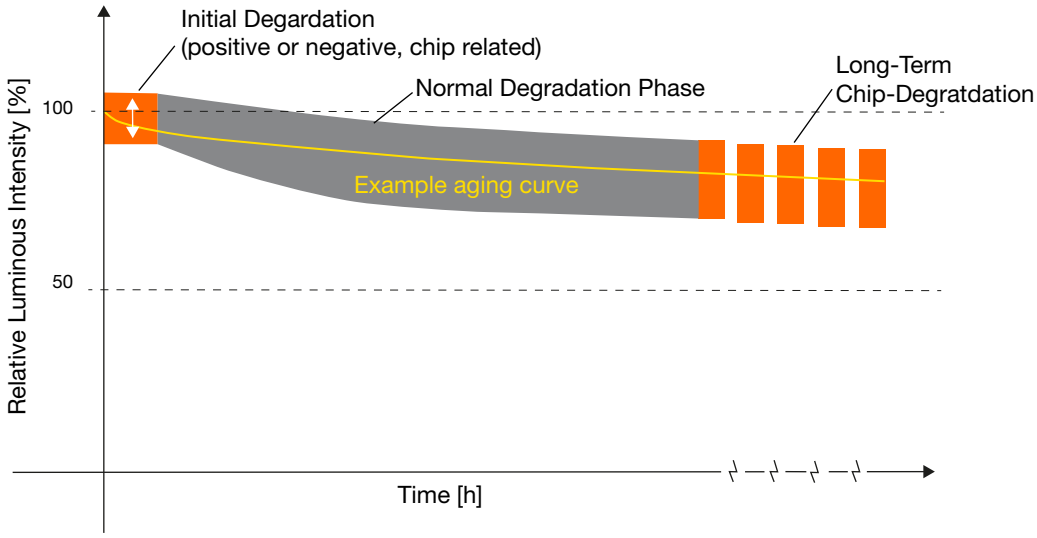
Since the junction temperature in applications cannot be measured, it is advisable to measure the temperature at an external reference point instead. For OSRAM Opto Semiconductors this reference point is the temperature T_S of the solder point. The solder point represents the transition from the active thermal path from the LED package to the soldering surfaces on the circuit board, and is dependent on the package technology. For OSLON® Black Series LEDs it is recommendable to measure the solder point temperature, if required, directly beside the leadframe substrate on the copper path for the thermal connection using a thin thermocouple (e.g., AWG 40).

If the operating current is increased in an environment that remains constant, the dissipation increases and the junction temperature rises as a result. This means that the choice of operating current has an effect on the degradation behavior of the LED.

If the degradation characteristics of the OSLON® Black Series LEDs are considered, thermal chip degradation is the decisive factor since the material deterioration of the plastic base, the silicon lens or the converter material within the specified parameters is minimal and can be ignored. Outside the specified parameters, deterioration or damage to the different package components may occur.

Highly efficient semiconductor chips with the latest thin-film technology from OSRAM Opto Semiconductors are used as light sources in the OSLON® Black Series LEDs. The chip technology uses the semiconductor material composition indium gallium nitride (ThinGaN) for the colors deep blue, true green and white, and the material composition aluminum indium gallium phosphides (ThinFilm) for the colors amber, yellow and red. Figure 3 schematically illustrates the typical degradation characteristics for the OSLON® Black Series product group.

Figure 3: Degradation characteristics of the OSLON® Black Series group



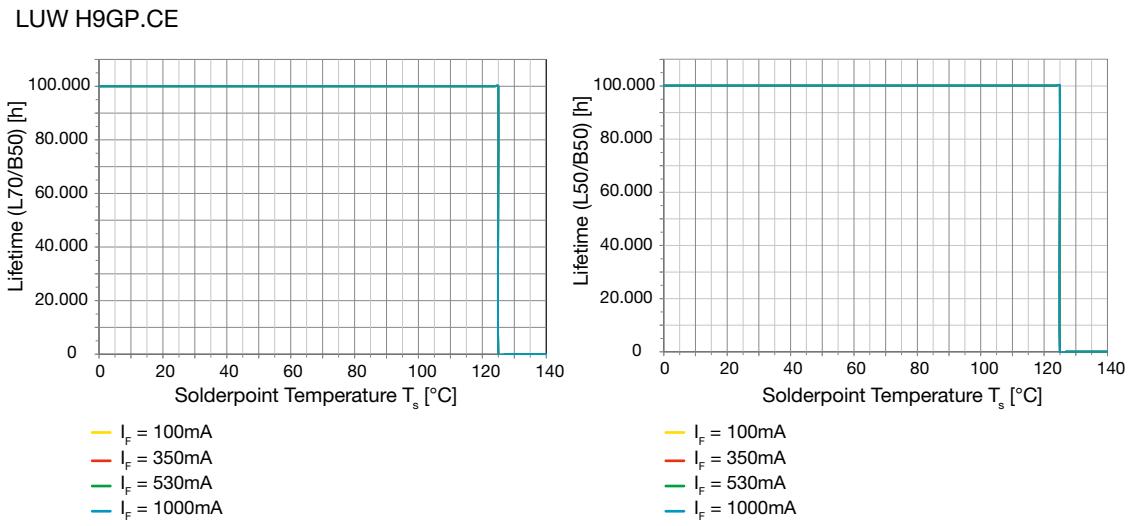
Further information on factors affecting the lifetime and reliability of LEDs, and on the definition of the failure parameters "lumen maintenance" (L) and "mortality" (B), can be found in the application note "AN006_Reliability and Lifetime of LEDs".

The following chapters provide specific information on the lifetime and degradation characteristics of the OSLON® Black Series group. A distinction is made between the ThinGaN (blue, green and white) and ThinFilm technologies (amber, yellow and red).

C. Lifetime and degradation characteristics of the OSLON® Black Series with ThinGaN technology

Figure 4 shows the charts with the expected lifetimes L70/B50 and L50/B50 of OSLON® Black Series LEDs with ThinGaN technology in relationship to the solder point temperature T_S. The resulting T_S curves are displayed in color for different operating conditions.

Figure 4: Lifetime[1] of the OSLON® Black Series with ThinGaN technology with respect to T_S



The calculation of the curves is based on the typical Rth value of the OSLON® Black Series LEDs (refer also to the application note "AN049_Package related thermal resistance of LEDs"). Different typical currents such as the group current of the type, or the minimum and maximum permissible current values, are used as operating currents.

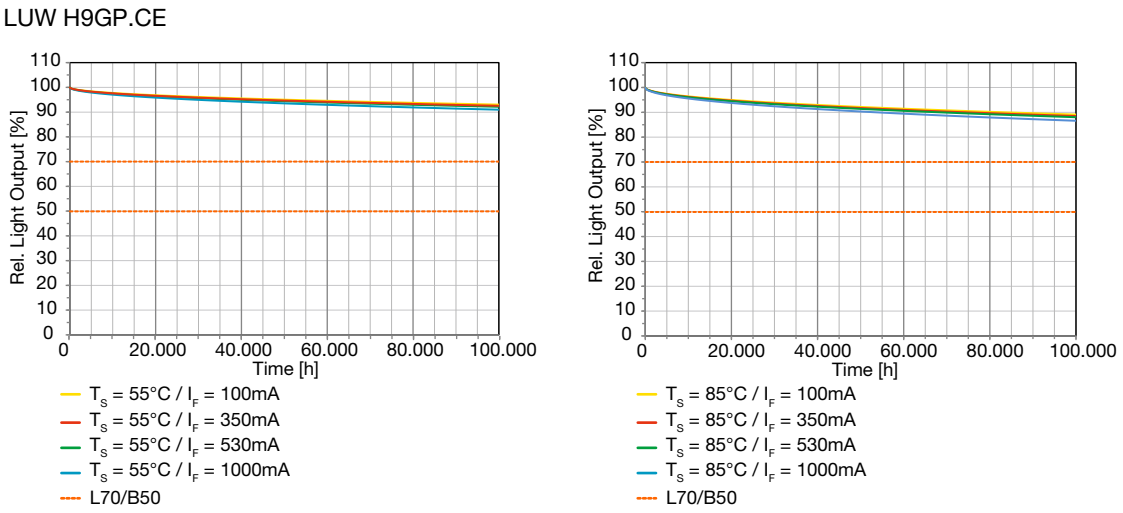
Example: An OSLON® Black Series (LUW H9GP) is operated with a current of 350 mA. A solder point temperature of T_S = 110°C was measured. An expected lifetime L70/B50 of about 100000h() is obtained.

However, in practical terms and for the application, knowledge of the degradation characteristics of the LEDs over their lifetimes is particularly important. To this end, OSRAM Opto Semiconductors carried out intensive long-term analyses and developed models that reproduce the expected degradation characteristics of the LEDs.

The degradation chart (Figure 5) for the OSLON® Black Series ThinGaN types refers to the solder point temperature T_S = 55°C and T_S = 85°C for different operating currents. The limits for L70/B50 and L50/B50 are shown as dashed lines.

[1]The failure criterion is the specified percentage of the initial luminous intensity. The numbers above represent estimations based on extrapolations. The actual value can differ depending on, but not limited to selected brightness binning, temperature at the LED, forward current, humidity, production variations and specific application conditions. As a result, these values cannot be warranted or guaranteed.

Figure 5: Degradation characteristics[1] of the OSLON® Black Series with ThinGaN technology for T_S = 55 °C & T_S = 85 °C (grouping current IF = 0.35 A)



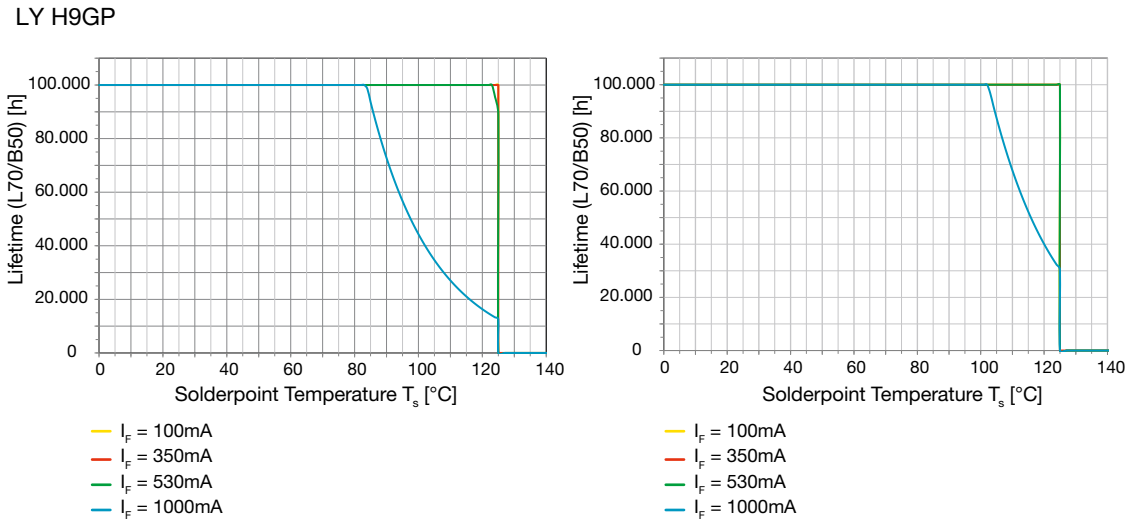
The charts show estimates based on extrapolations and represent typical value curves (B50). The actual values can deviate from those shown due to specific application conditions, production variations, the selected brightness binning, humidity or other factors.

D. Lifetime and degradation characteristics of the OSLON® Black Series with ThinFilm technology

Figure 6 graphically shows the charts with the expected lifetimes L70/B50 and L50/B50 of the individual OSLON® Black Series products with ThinFilm technology in relationship to the solder point temperature T_S. With ThinFilm technology, the degradation characteristics vary not only with the temperature, but also with the current density. The resulting T_S curves are displayed in color for different operating conditions.

[1]The failure criterion is the specified percentage of the initial luminous intensity. The numbers above represent estimations based on extrapolations. The actual value can differ depending on, but not limited to selected brightness binning, temperature at the LED, forward current, humidity, production variations and specific application conditions. As a result, these values cannot be warranted or guaranteed.

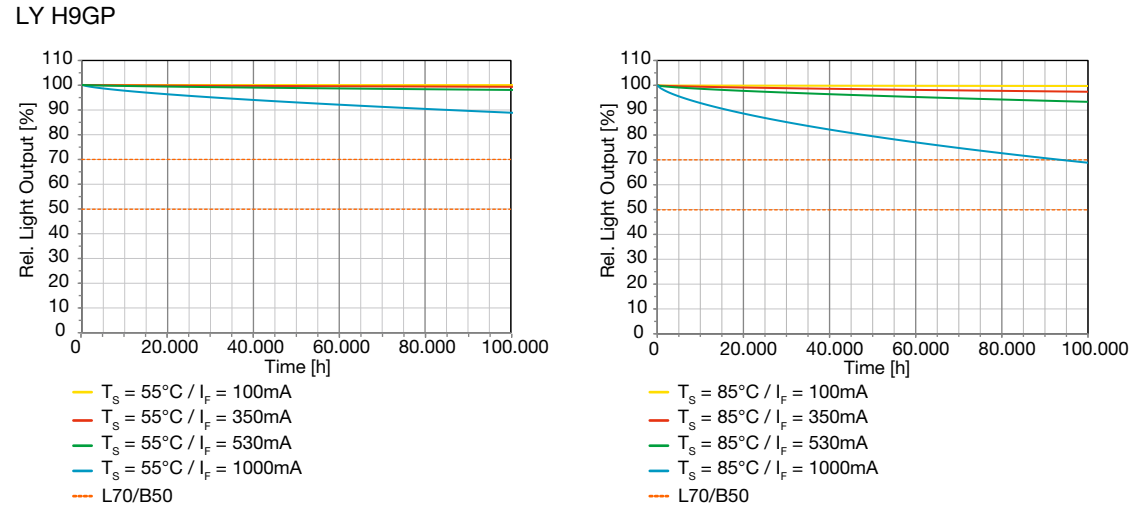
Figure 6: Lifetime[1] of the OSLON® Black Series with ThinFilm technology with respect to T_S



Different typical currents such as the group current of the type, or the minimum and maximum permissible current values, were also used as operating currents. The reading principle is the same as for the ThinGaN technology.

The degradation characteristics charts (Figure 7) refer analogously to the two solder point temperatures $T_S = 55°C$ and $T_S = 85°C$ for different operating currents. The limits for L70/B50 and L50/B50 are also shown here.

Figure 7: Degradation characteristics[1] of the OSLON® Black Series with ThinFilm technology for $T_S = 55°C$ & $T_S = 85°C$ (grouping current IF = 0.35 A)



[1]The failure criterion is the specified percentage of the initial luminous intensity. The numbers above represent estimations based on extrapolations. The actual value can differ depending on, but not limited to selected brightness binning, temperature at the LED, forward current, humidity, production variations and specific application conditions. As a result, these values cannot be warranted or guaranteed.

E. Summary

With their compact, robust package, the LEDs in the OSLON® Black Series product family offer developers and designers an excellent starting point for designing highly efficient, durable light sources with extremely long lifetimes.

As can be seen from the charts, the LEDs in the OSLON® Black Series group – in combination with an adequate thermal management system and depending on the selected operating conditions – achieve typical lifetimes of more than 100,000 hours. This corresponds to continuous operation of longer than 11-and-a-half years.

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ABOUT OSRAM OPTO SEMICONDUCTORS

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