Reliability of the OSLON Product Family

Application Note

Introduction

This Application Note provides an overview of the performance of the OSLON 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 "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 product family – by providing a competent thermal management system.

OSLON Product family

The OSLON group was developed particularly for applications that require maximum luminous flux with little consumption of space and also the most stringent requirements regarding lifetime are imposed. With their performance and design they are suitable for diverse areas of lighting and illumination technology, ranging from general lighting to automotive applications. Due to their very compact design, the LEDs are also particularly suitable for combining and operating in clusters.

Figure 1 shows an overview of the OSLON family with its different types and the available color and white variations.

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

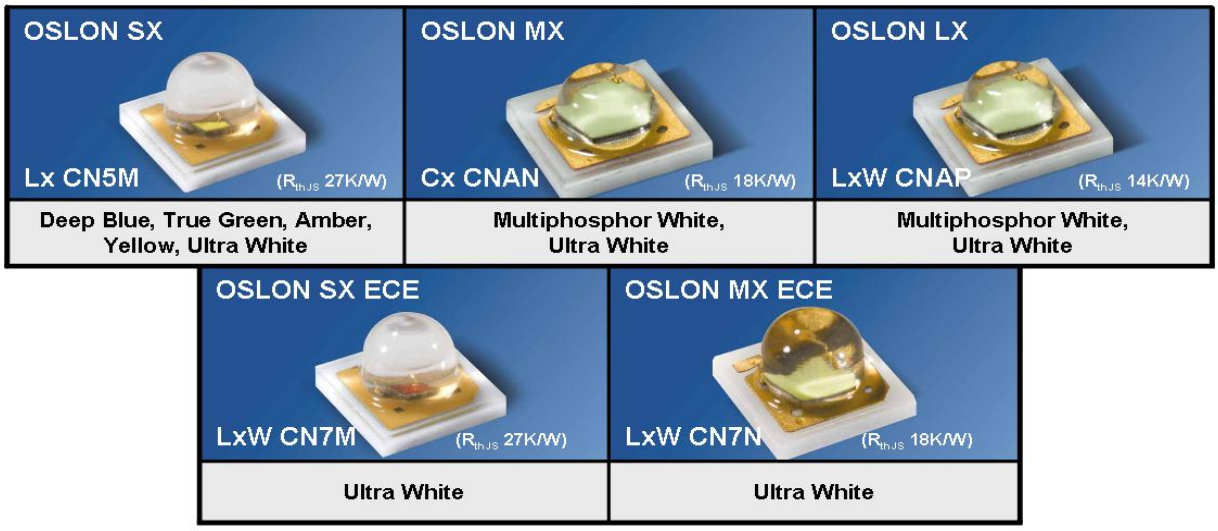

Figure 1: Overview of the OSLON product family

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As with all other LEDs from OSRAM Opto Semiconductors, the OSLON products also comply with the applicable RoHS specifications (EU and China) and do not contain any lead or other hazardous substances.

Construction and degradation mechanisms of the OSLON

The design of the OSLON group is based on a joint package concept comprising a ceramic base with integrated contacts (bottom only-terminated) and a hard silicone cast as a lens (Figure 2).

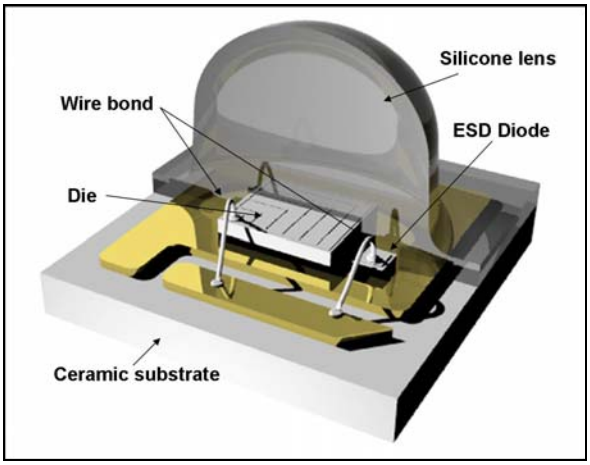

Figure 2: Construction of the OSLON product family

The ceramic base has the decisive advantage that it has stable degradation characteristics in regard to light, regardless of the wavelength.
In addition, it has sufficiently good thermal conductivity and enables thermal connection to the p.c. board to be designed electrically neutral.

A major factor affecting the lifetime of an OSLON LED is the temperature of the light-emitting layer (T_j) at which the LED is operated in the application.
The lower the junction temperature T_j, 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 LEDs, it is recommendable to measure the solder point temperature, if required, as near as possible to the thermal connection between the ceramic substrate and circuit board (PCB) using a thin thermocouple (e.g., AWG 40).

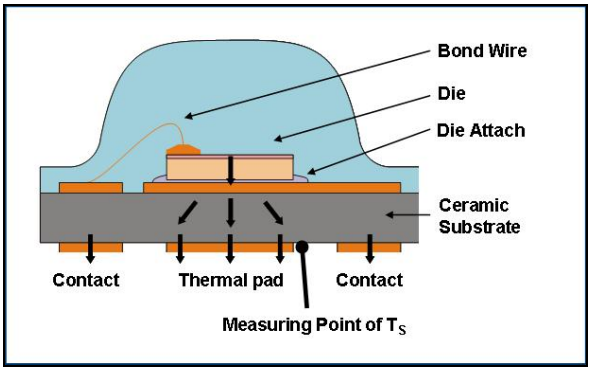

Figure 3: Primary heat flow in the OSLON products

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 LEDs are considered, thermal chip ageing is the decisive factor since the material deterioration of the ceramic bases, the silicone lens or the converter material within the specified parameters 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 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 4 schematically illustrates the typical degradation characteristics for the OSLON product family.

Further information on factors affecting the lifetime and reliability of LEDs, and on the definition of the failure parameters "lumen maintenance" (L) and "catastrophic failure" (B), can be found in the Application Note "Reliability and Lifetime of LEDs".

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

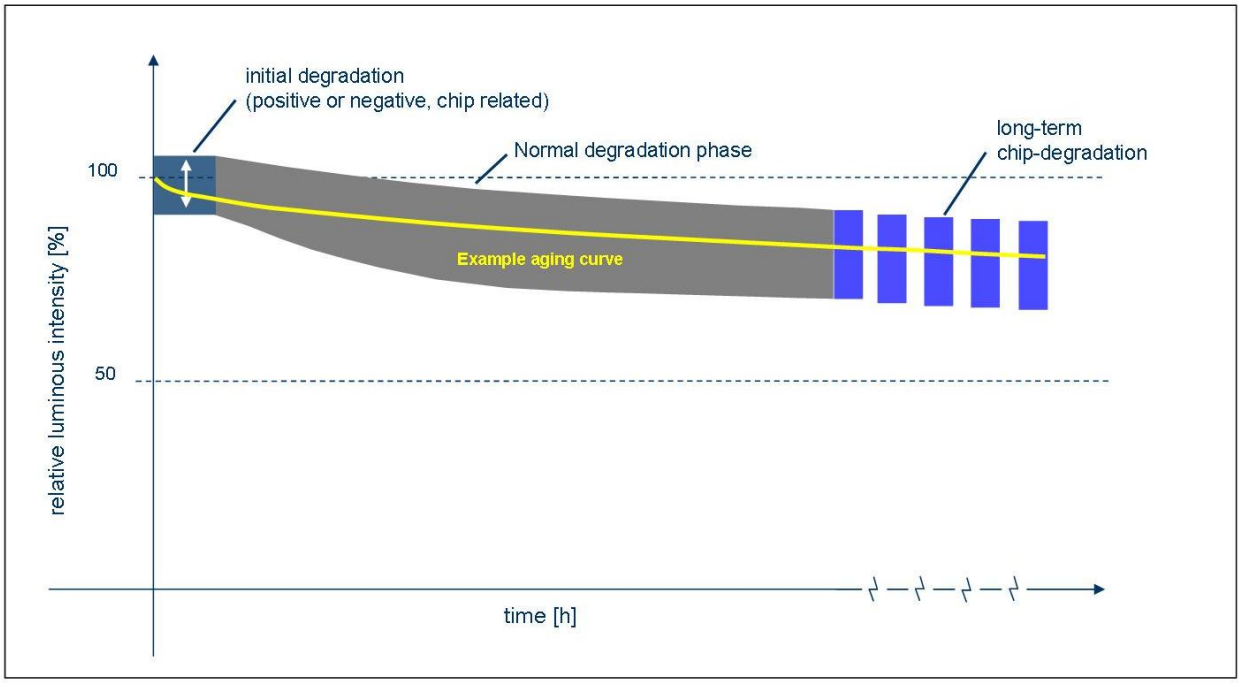

Figure 4: Degradation characteristics of the OSLON products

Lifetime and degradation characteristics of OSLON with ThinGaN technology

Figures 5a & 5b below show the charts with the expected lifetimes L70/B50 and L50/B50 of OSLON 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.

The calculation of the curves is based on the typical R_{th} value of the OSLON LEDs (refer also to the Application Note "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 SX (LUW CN5M) is operated with a current of 200 mA. A solder point temperature of $T_S = 90$ °C was measured. An expected lifetime L70/B50 of 80000h(*) is obtained.

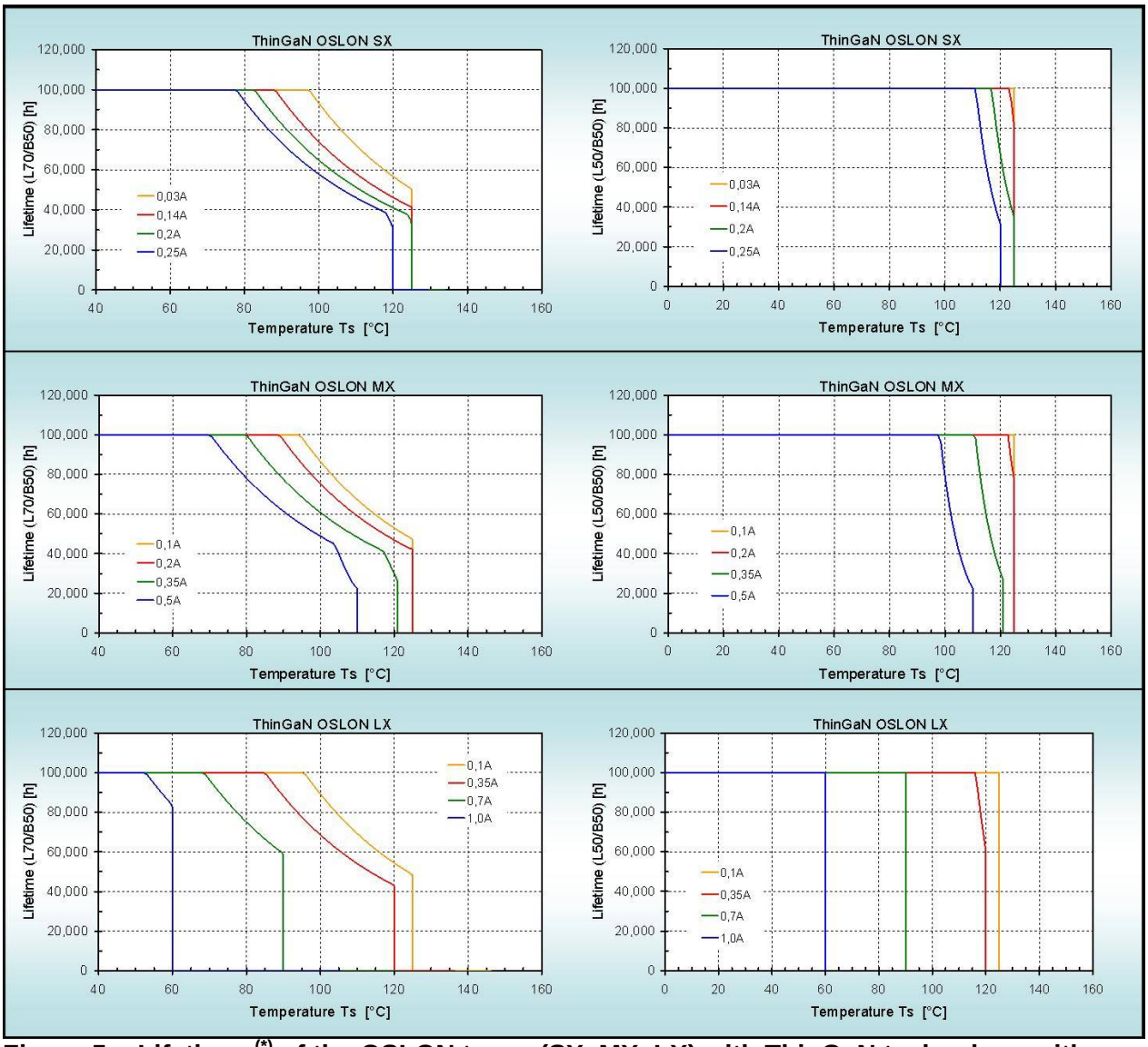

Figure 5a: Lifetimes(*) of the OSLON types (SX, MX, LX) with ThinGaN technology with respect to T_S

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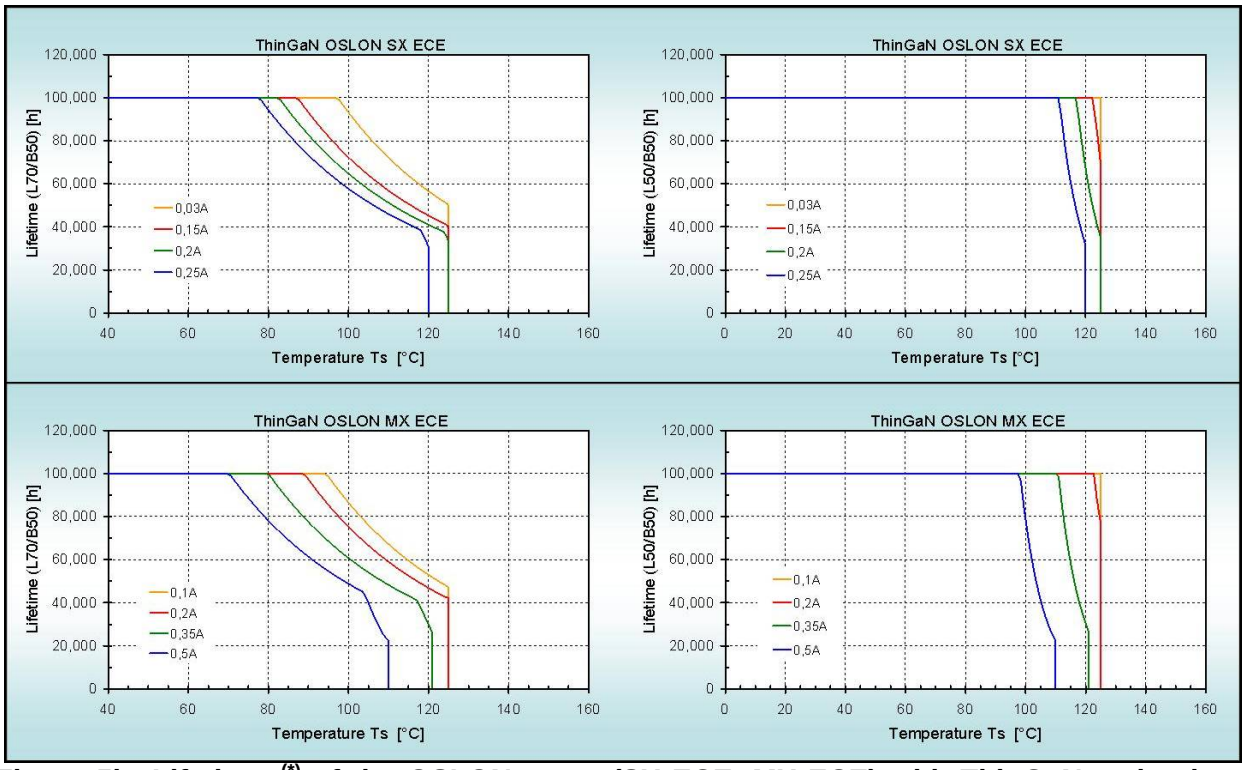

Figure 5b: Lifetimes(*) of the OSLON types (SX ECE, MX ECE) with ThinGaN technology with respect to T_S

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 following degradation characteristics charts (Figure 6a-e) refer to the 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 shown as dashed lines.

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.

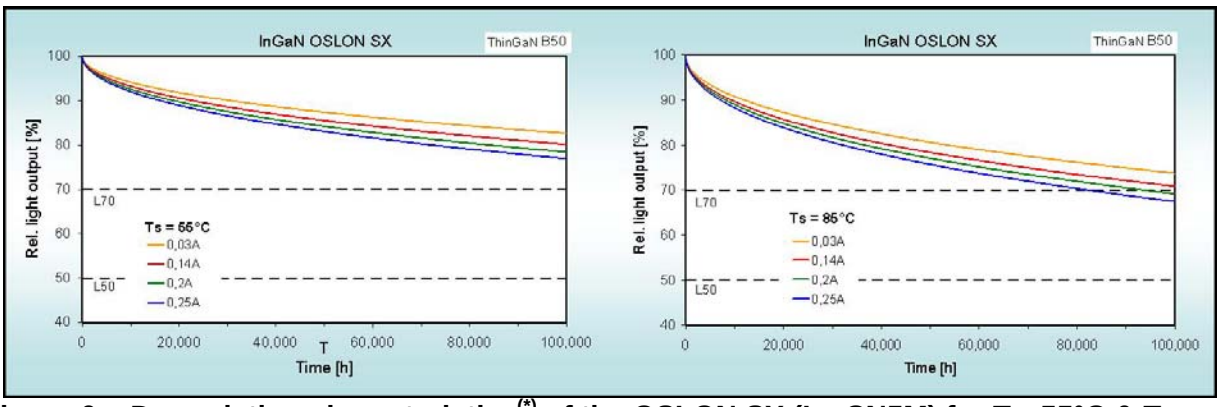

Figure 6a: Degradation characteristics(*) of the OSLON SX (Lx CN5M) for T_S=55°C & T_S= 85°C (grouping current I_F = 0,14A)

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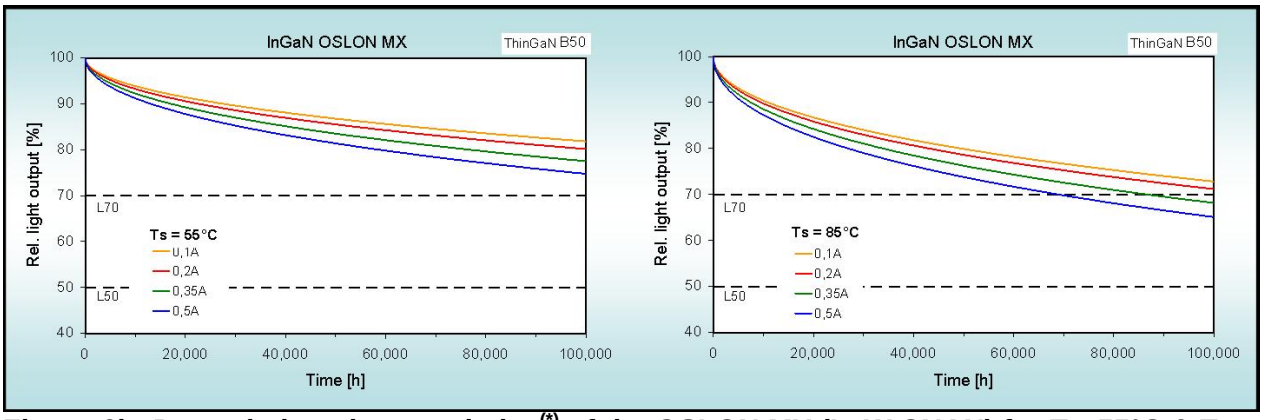

Figure 6b: Degradation characteristics(*) of the OSLON MX (LxW CNAN) for T_S=55°C & T_S= 85°C (grouping current I_F = 0,20A)

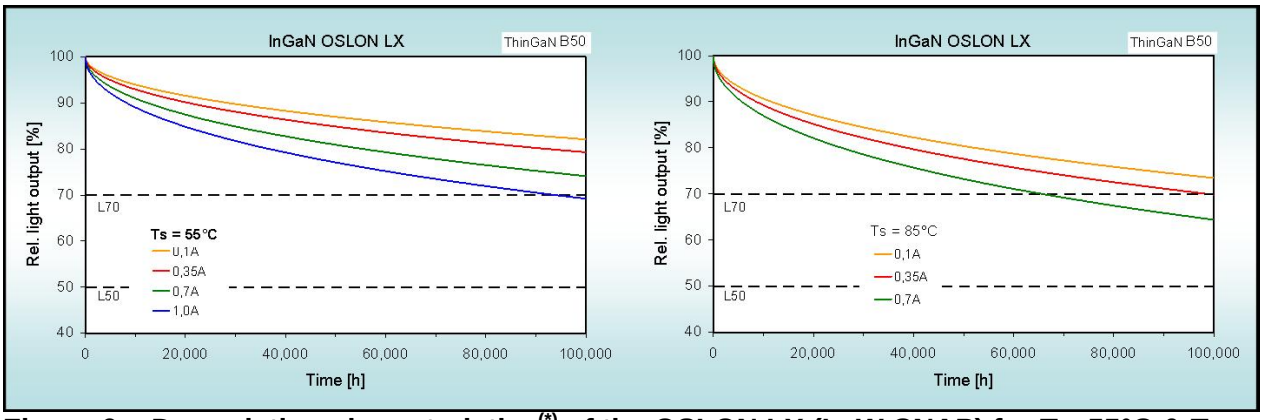

Figure 6c: Degradation characteristics(*) of the OSLON LX (LxW CNAP) for T_S=55°C & T_S= 85°C (grouping current I_F = 0,35A)

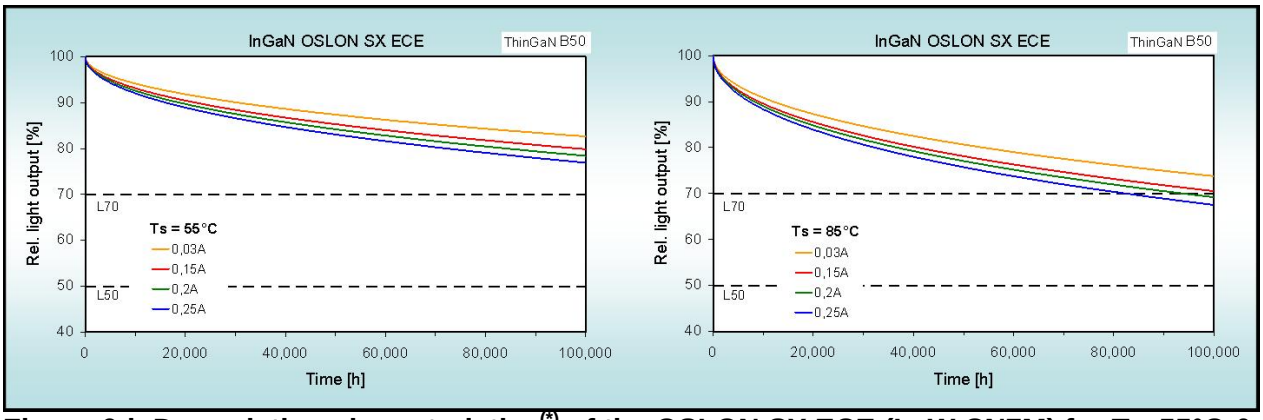

Figure 6d: Degradation characteristics(*) of the OSLON SX ECE (LxW CN7M) for T_S=55°C & T_S= 85°C (grouping current I_F = 0,20A)

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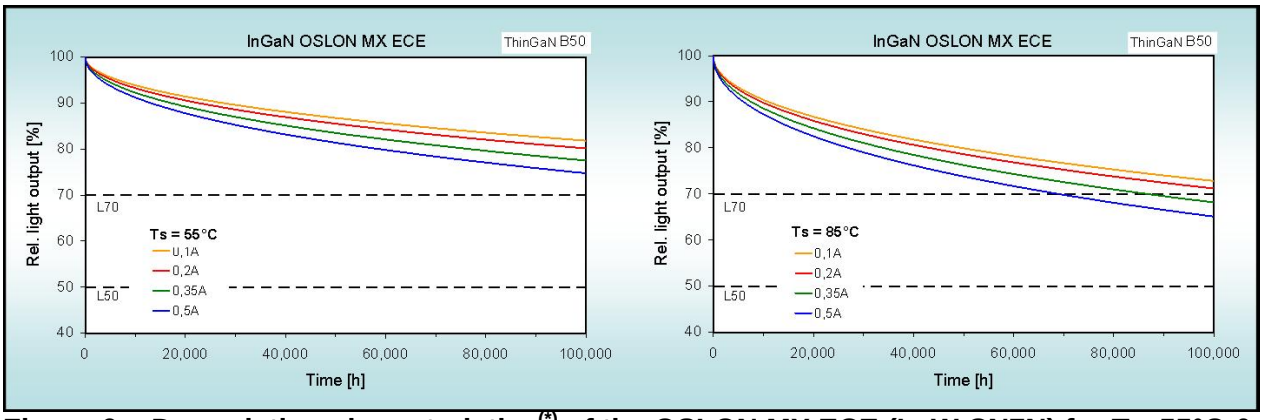

Figure 6e: Degradation characteristics(*) of the OSLON MX ECE (LxW CN7N) for T_S=55°C & T_S= 85°C (grouping current I_F = 0,35A)

Lifetime and degradation characteristics of OSLON with ThinFilm technology

Figure 7 below graphically shows the charts with the expected lifetimes L70/B50 and L50/B50 of OSLON LEDs with ThinFilm technology (InGaAlP) in relationship to the solder point temperature T_S.
With ThinFilm technology, the degradation characteristics vary not only with the junction temperature, but also with the current density.

The resulting T_S curves are displayed in color for different operating conditions.
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 8) refer analogously to the two solder point temperatures T_S = 55° and T_S = 85 °C for different operating currents. The limits for L70/B50 and L50/B50 are also shown here.

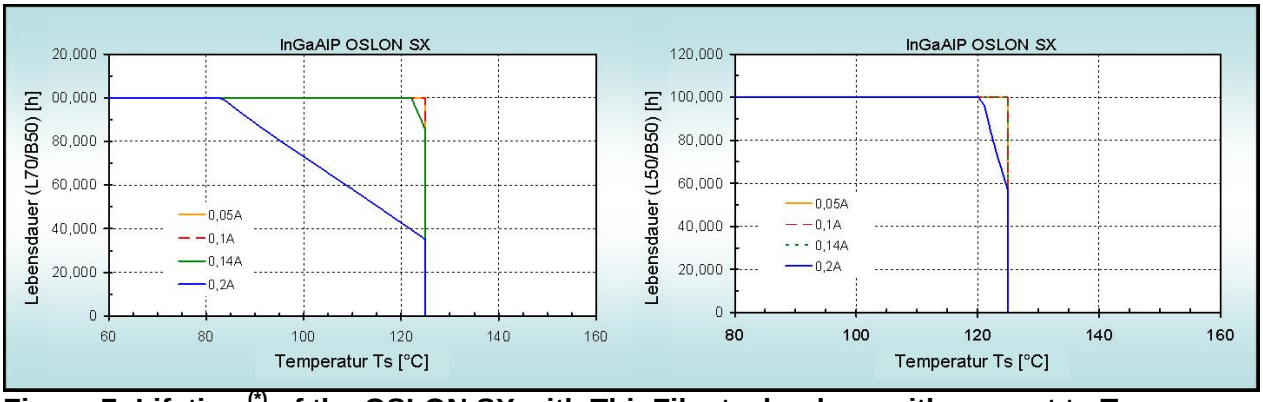

Figure 7: Lifetime(*) of the OSLON SX with ThinFilm technology with respect to T_S

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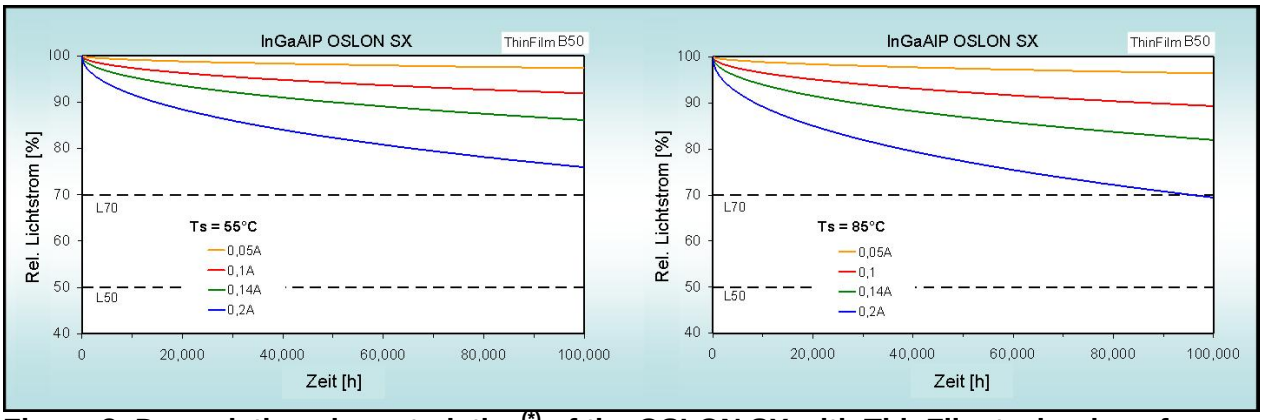

Figure 8: Degradation characteristics(*) of the OSLON SX with ThinFilm technology for T_S=55°C & T_S= 85°C (grouping current I_F = 0,14A)

Summary

With their compact, stable package, the LEDs in the OSLON product family offer developers and designers an excellent starting point for designing highly efficient, reliable and extremely durable light sources.

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

(*) 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 can not be warranted or guaranteed.

Appendix

Don't forget: LED Light for you is your place to be whenever you are looking for information or worldwide partners for your LED Lighting project.

www.ledlightforyou.com

ABOUT OSRAM OPTO SEMICONDUCTORS

OSRAM is part of the Industry sector of Siemens and one of the two leading lighting manufacturers in the world. Its subsidiary, OSRAM Opto Semiconductors GmbH in Regensburg (Germany), offers its customers solutions based on semiconductor technology for lighting, sensor and visualization applications. OSRAM Opto Semiconductors has production sites in Regensburg (Germany) and Penang (Malaysia). Its headquarters for North America is in Sunnyvale (USA), and for Asia in Hong Kong. OSRAM Opto Semiconductors also has sales offices throughout the world. For more information go to www.osram-os.com.

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