Application Note No. AN009

OSRAM
Opto Semiconductors

Reliability of the OSLON® product family

Application Note

Valid for:
OSLON® SX / OSLON® SX ECE /
OSLON® MX ECE /
OSLON® LX ECE

Abstract

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.

Further information: Please also visit the OSRAM Opto Semiconductors web site for the OSLON® product portfolio.

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A. The OSLON® product family

The OSLON® group was especially developed for applications that require maximum luminous flux with a low space requirement and where the most stringent requirements regarding lifetime are also imposed. With their performance and design they are suitable for various 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 lead-free reflow soldering.

Figure 1: Overview of the OSLON® product family

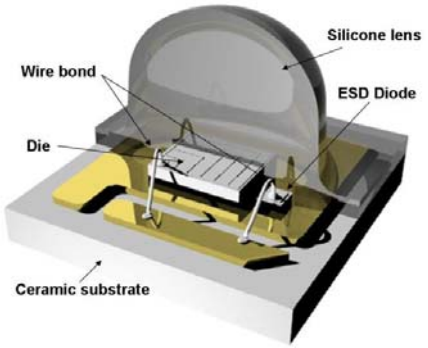
OSLON® SX | OSLON® SX ECE | OSLON® LX ECE | OSLON® MX ECE

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.

B. Design and degradation mechanisms of the OSLON® product family

The design of the OSLON® product family 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: Design of the OSLON® product family



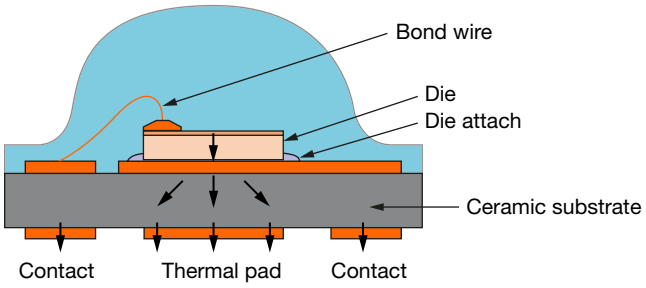
The fact that the ceramic base features stable light characteristics regardless of the wavelength is a major advantage. In addition, it has sufficiently good thermal conductivity and enables to design the thermal connection to the PCB electrically neutral.

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 of the LED package to the soldering surfaces on the circuit board, and is dependent on the package technology.

For OSLON® LEDs, it is recommended to measure the solder point temperature, if required, as close 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.

When considering the degradation characteristics of the OSLON® LEDs, thermal chip aging 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.

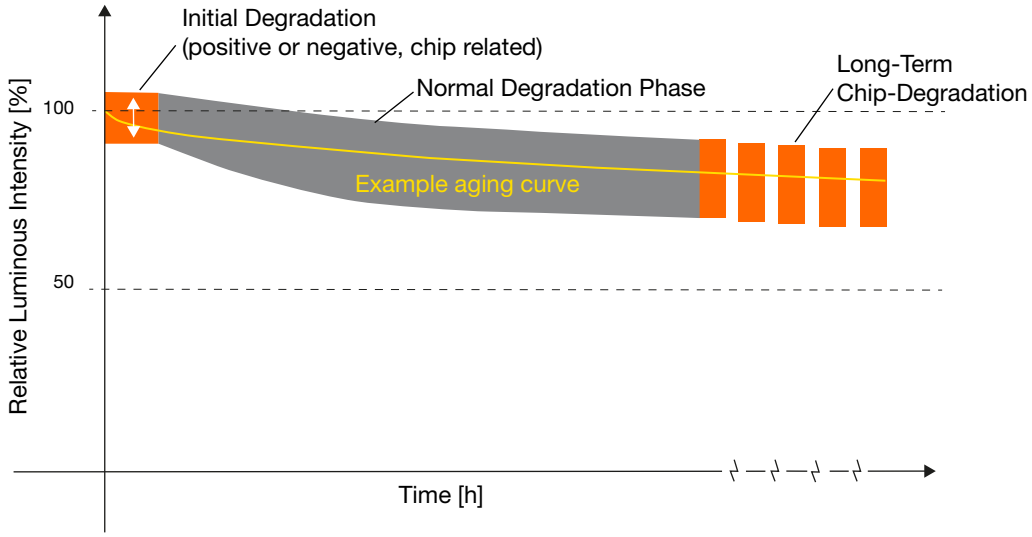
If the specified parameters are not observed, deterioration or damage to the different package components may occur.

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 provides a schematic illustration of 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 “mortality” (B), can be found in the application note “Reliability and lifetime of LEDs”.

Figure 4: Degradation characteristics of the OSLON® products



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).

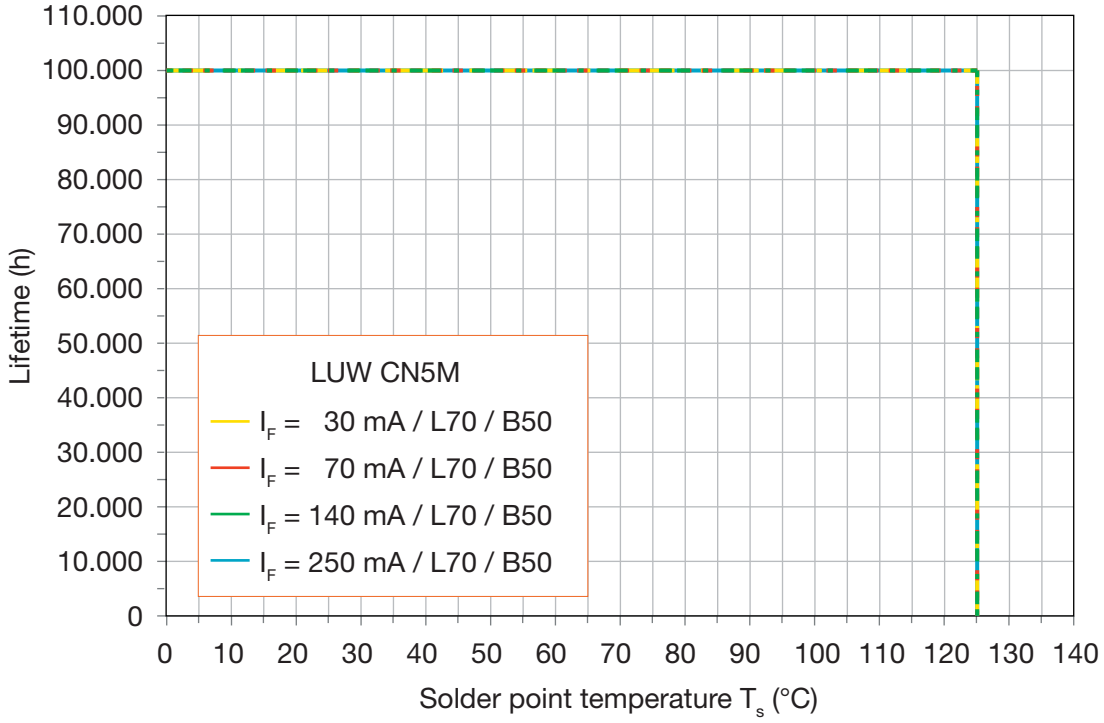
C. Lifetime and degradation characteristics with ThinGaN technology

The Figures 5, 6 and 7 below show the charts with the expected lifetimes L70 / B50 of OSLON® LEDs with ThinGaN technology in relation 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 (also refer 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 140 mA. A solder point temperature of T_S = 90 °C was measured. An expected lifetime L70 / B50 of 100,000 h[1] is obtained.

Figure 5: Lifetimes[1] of the OSLON® types (SX) with ThinGaN technology with respect to T_S



[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 can not be warranted or guaranteed.

Figure 6: Lifetimes[1] of the OSLON® types (SX ECE, MX ECE) with ThinGaN technology with respect to T_S

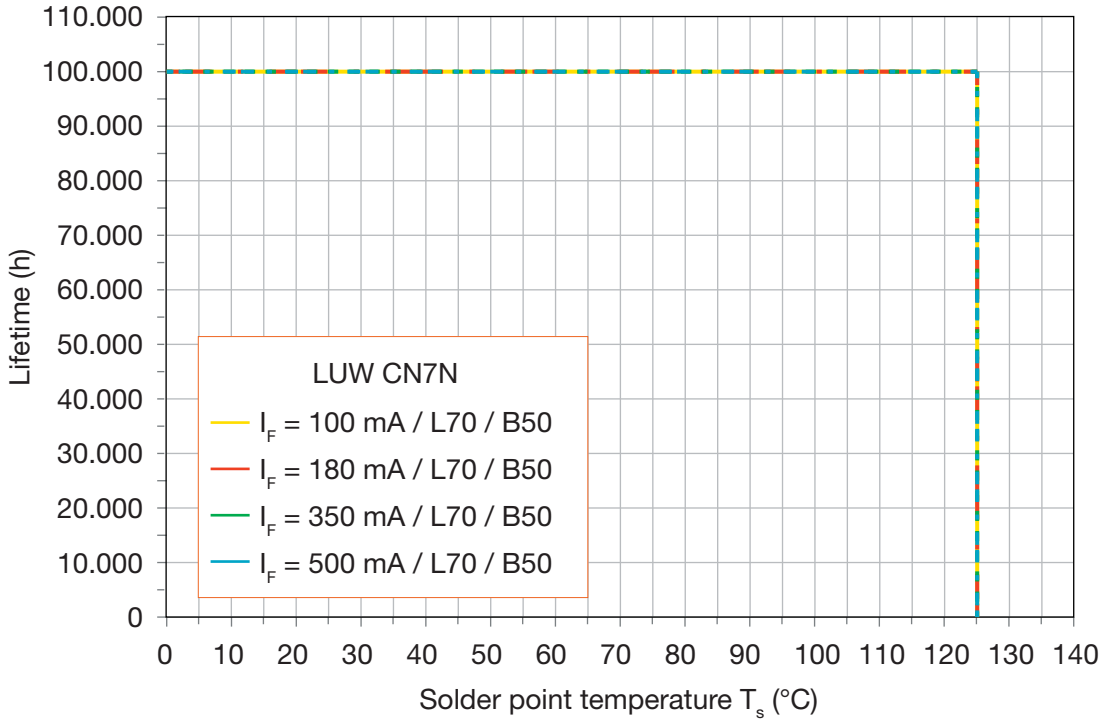
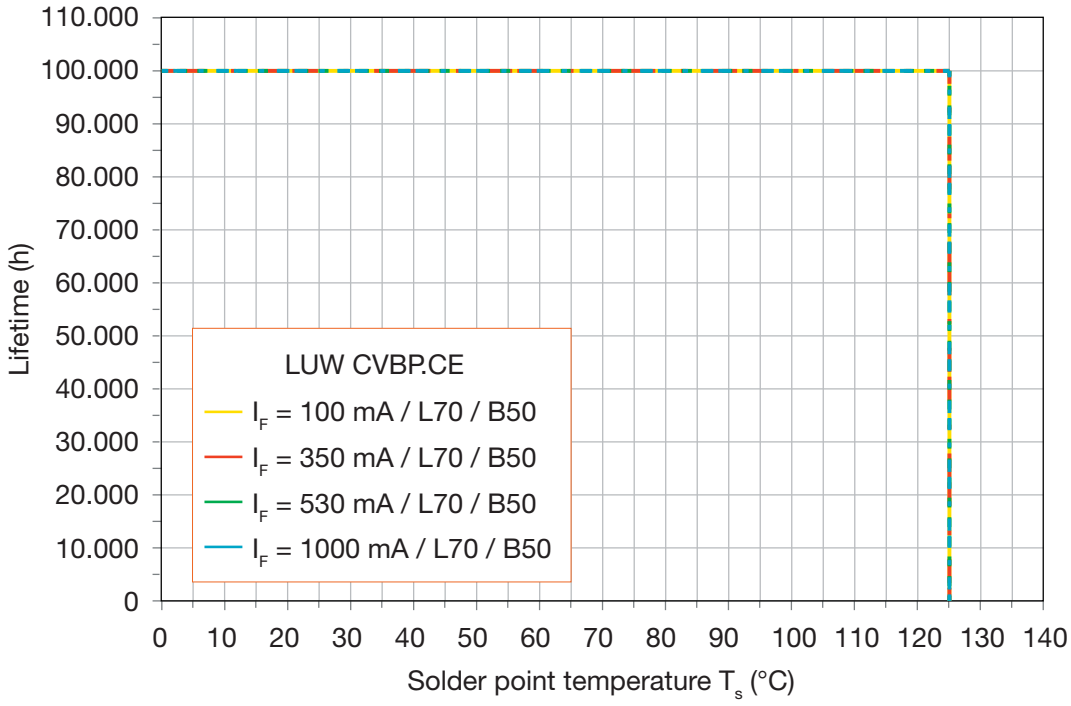


Figure 7: Lifetimes[1] of the OSLON® types (LX) with ThinGaN technology with respect to T_S



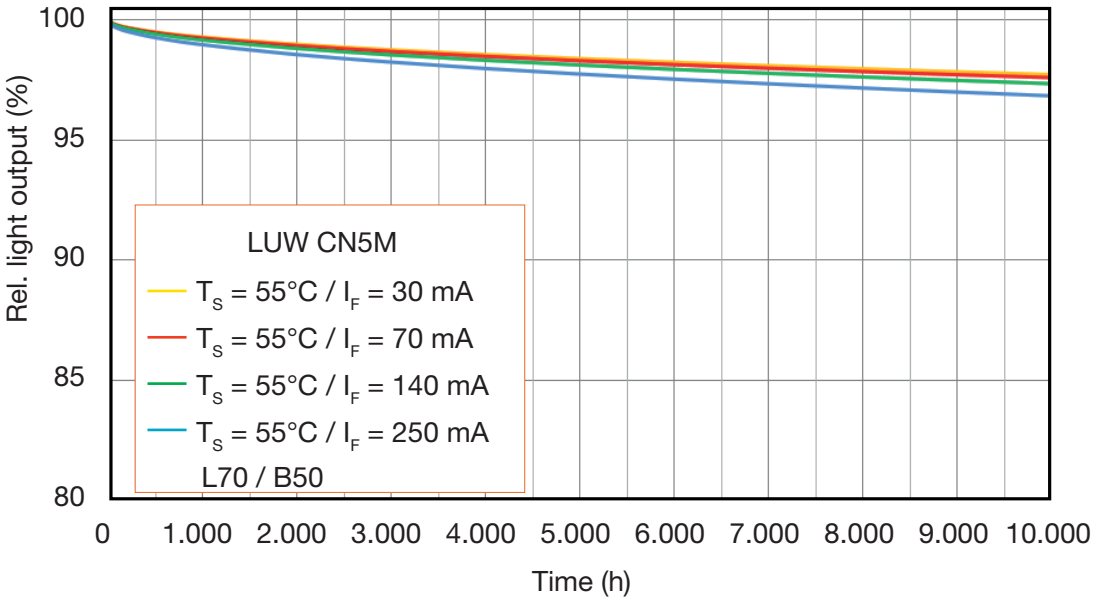
However, in practical terms and for the application, knowledge of the degradation characteristics of the LEDs over their lifetimes is particularly

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 (Figures 8 — 11) refer to the solder point temperatures T_S = 55 °C and T_S = 85 °C for different operating currents with limits L70 / B50.

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

Figure 8: Degradation characteristics[1] of the OSLON® SX (LxW CN5M) for T_S = 55 °C and T_S = 85 °C (grouping current I_F = 0.14 A)



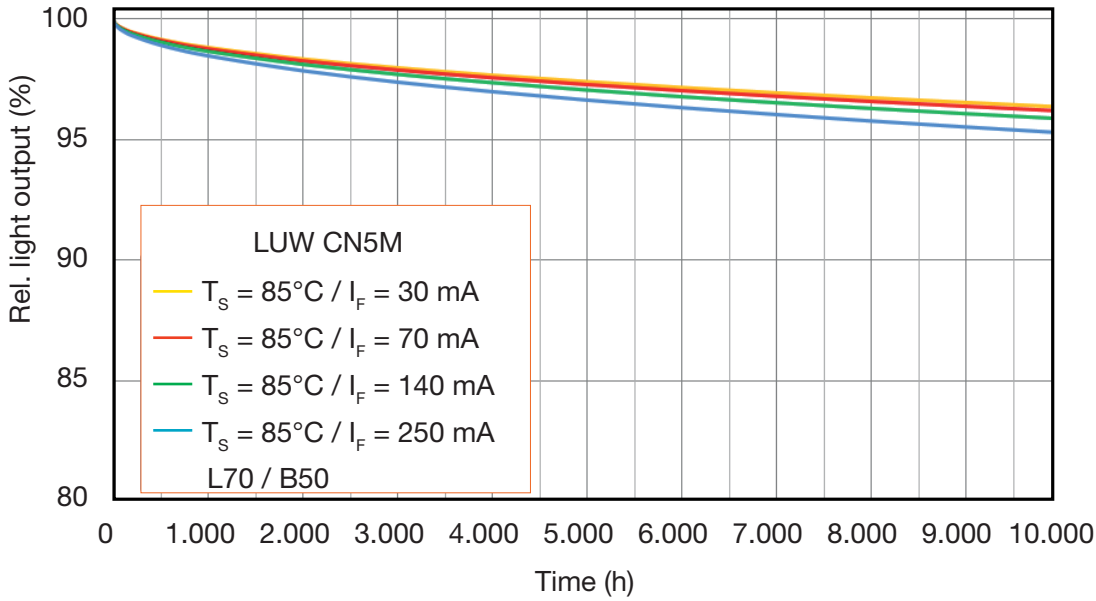


Figure 9: Degradation characteristics[1] of the OSLON® SX ECE (LxW CN7M) for T_S = 55 °C and T_S = 85 °C (grouping current I_F = 0.20 A)

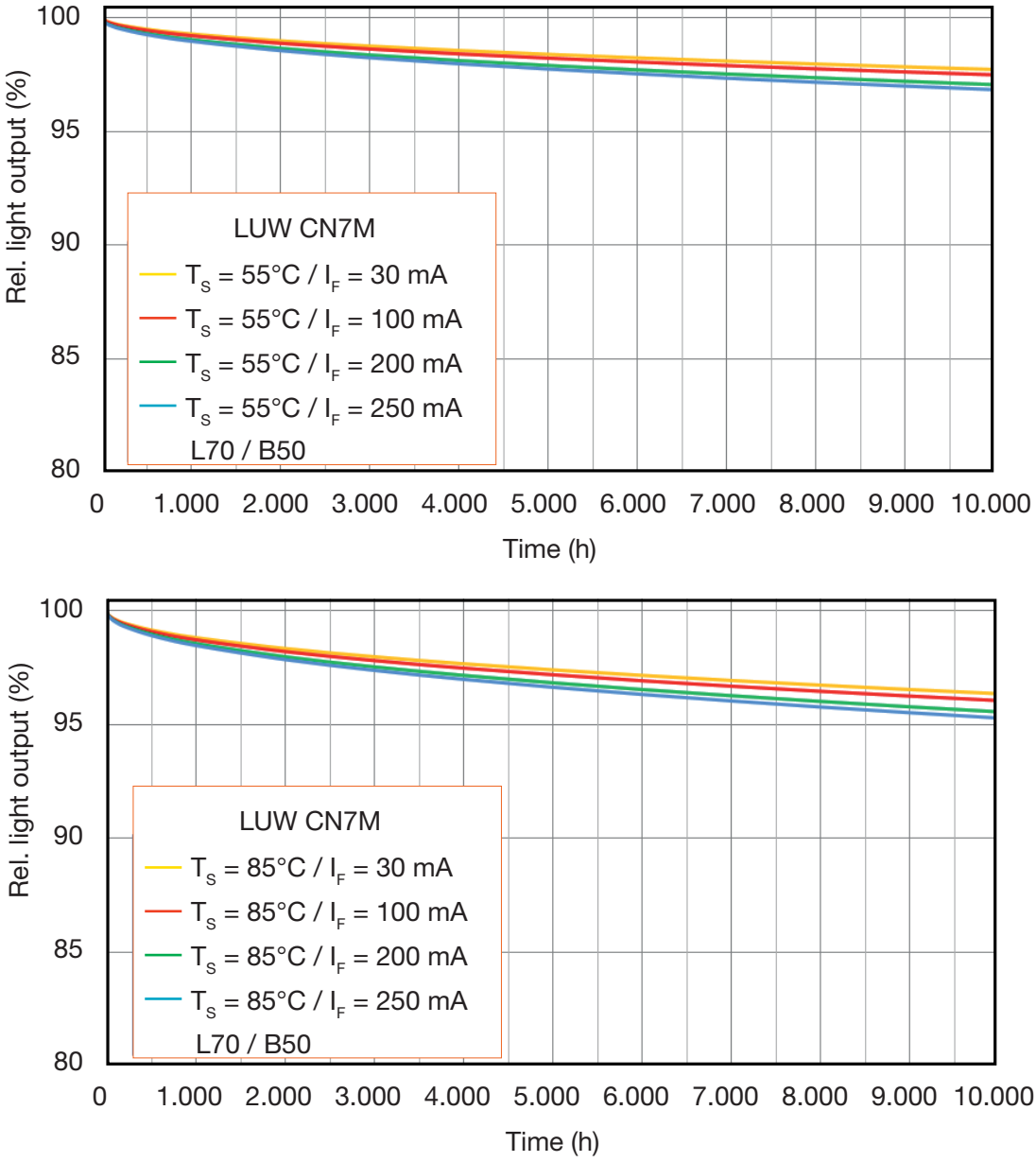


Figure 10: Degradation characteristics[1] of the OSLON® MX ECE (LxW CN7N) for T_S = 55 °C and T_S = 85 °C (grouping current I_F = 0.35 A)

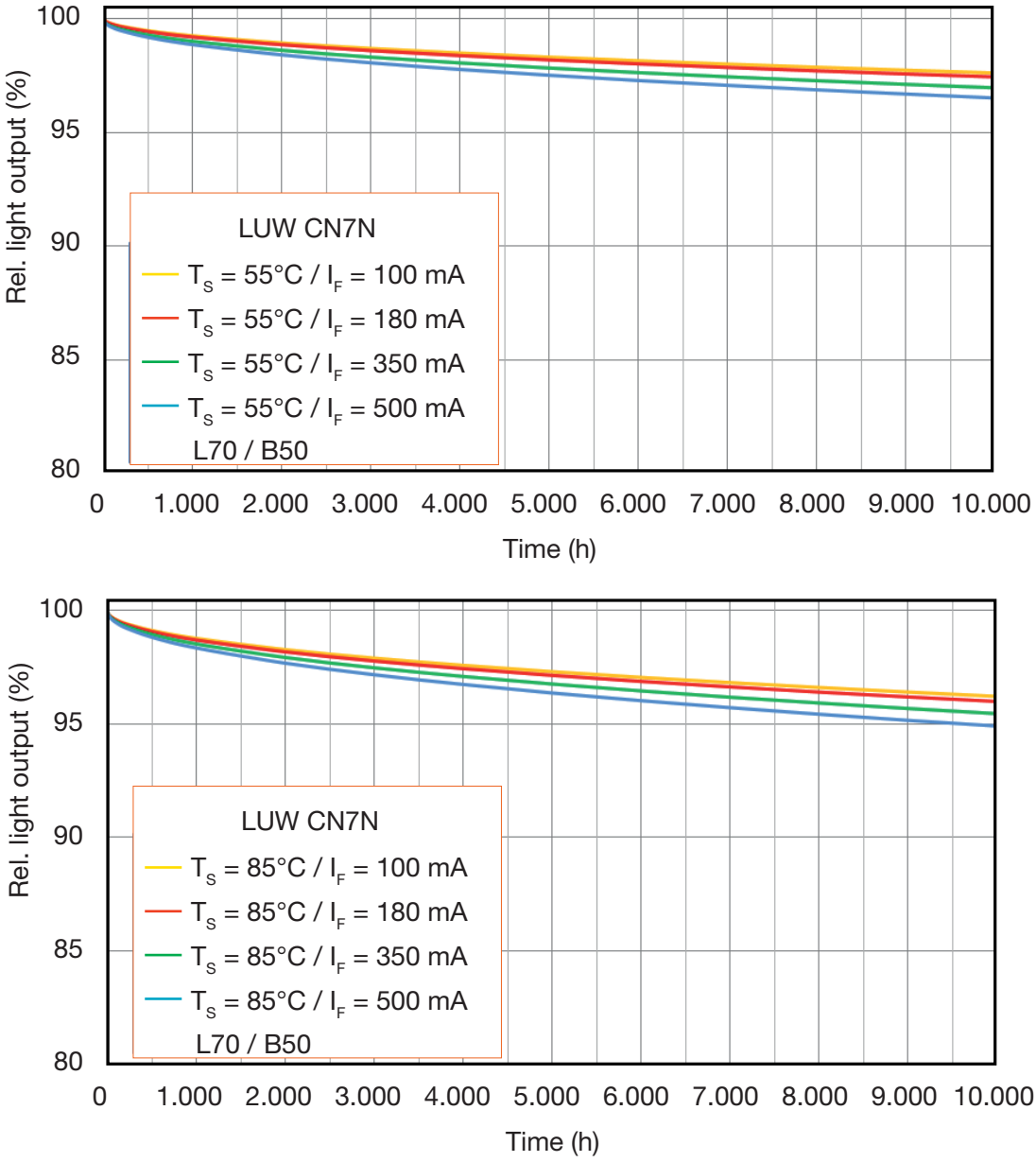
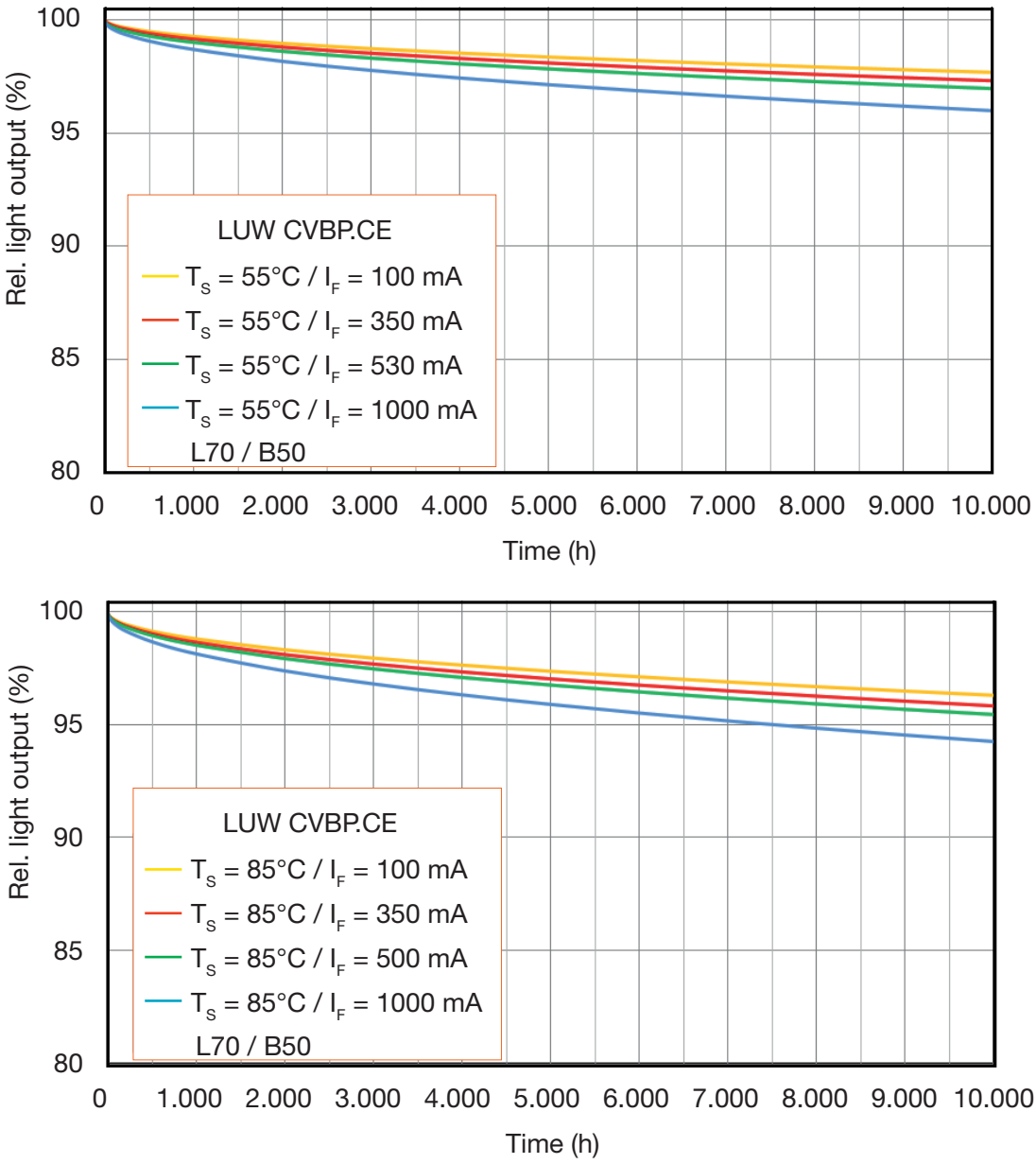


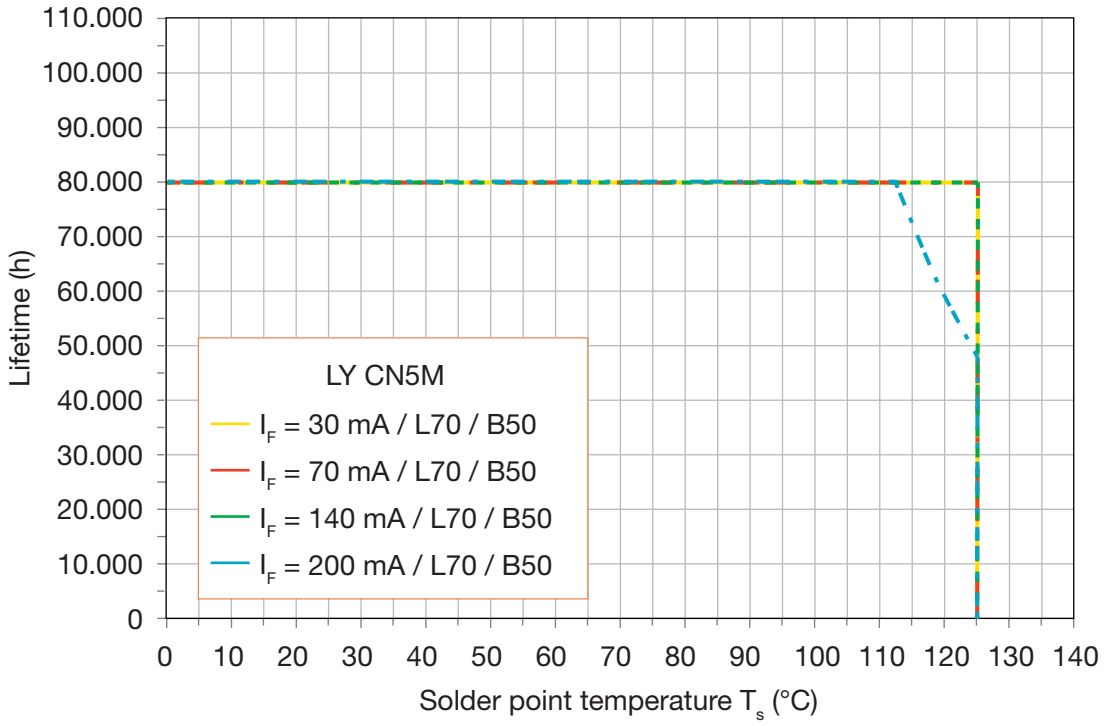
Figure 11: Degradation characteristics[1] of the OSLON® LX ECE (LxW CVBP) for T_S = 55 °C and T_S = 85 °C (grouping current I_F = 0.35 A



D. Lifetime and degradation characteristics with ThinFilm technology

Figure 12 below graphically shows the charts with the expected lifetime L70/B50 of OSLON® LEDs with ThinFilm technology (InGaAlP) graphically in relation 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.

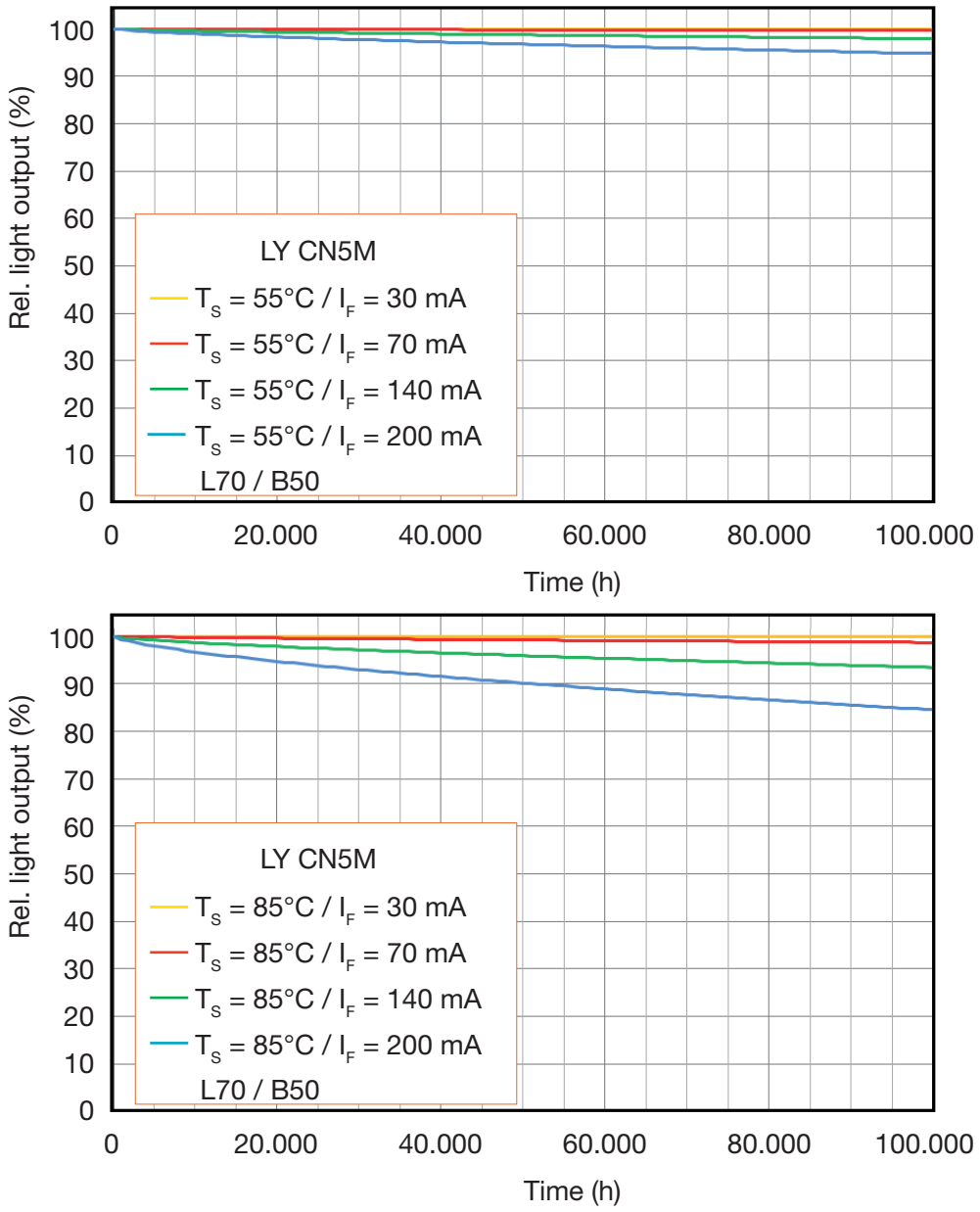
Figure 12: Lifetime[1] of the OSLON® SX with ThinFilm technology with respect to T_S



The resulting T_S curves are displayed in color for various 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 13) refer analogously to the two solder point temperatures $T_S = 55$ °C and $T_S = 85$ °C for different operating currents. The limits are L70 / B50.

Figure 13: Degradation characteristics[1] of the OSLON® SX with ThinFilm technology for T_S = 55 °C and T_S = 85 °C (grouping current I_F = 0.14 A)



E. Summary

With their compact, stable package, the LEDs in the OSLON® product family offers 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 100,00 hours. This corresponds to continuous operation of about eleven and a half years.

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, Munich, Germany is one of the two leading light 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), Penang (Malaysia) and Wuxi (China). 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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