

# Influence of the Cooling System on Characteristics of Power LEDs in COB Packages

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## EXTENDED ABSTRACT

Power LEDs are a basic component of modern lighting systems. They usually contain many diode chips mounted on a common substrate and emitting a desired luminous flux value. COB (Chip on Board) devices contain many diode chips placed on a common ceramic substrate, connected in series-parallel and covered with a common phosphor layer.

Despite the big number of papers on the study of power LEDs in COB packages, there is still a lack of information in the literature on the study of non-isothermal characteristics of these devices obtained at different cooling conditions.

The aim of this paper is to present the results of experimental studies illustrating the effect of self-heating on the electrical characteristics and optical and radiometric parameters of power LEDs in COB packages. Two components with different sizes and different permissible values of forward current were selected for the studies. Devices operating under different cooling conditions were considered.

Two power LEDs in COB packages manufactured by Cree were selected for the tests: CXB2540-0000-000N0ZU4L5A (hereinafter referred to as CXB2540) and CXB1507-0000-000F0ZG2L5A (hereinafter referred to as CXB1507). Both devices under consideration are characterized by the same value of correlated colour temperature CCT = 4000 K and colour rendering index CRI = 95. The CXB2540 diode allows to obtain more than 5 times higher luminous flux, 3 times higher forward current and 2 times higher forward voltage.

The tested diodes differ in the size of the substrate. They are 16x16 mm for the CXB1507F diode and 24x24 mm for the CXB2540 diode. Diode chips are mounted in a circle with a diameter of 9 and 19 mm, respectively. The CXB1507F diode contains 24 semiconductor chips connected in 4 parallel chains of 6 chips each. In turn, the CXB2540 diode contains 120 semiconductor chips connected in 10 parallel chains of 12 chips each. The ceramic substrate of each of the tested diodes is 1 mm thick.

The measurements were performed for three variants of the cooling system of the tested diodes. In the first one, the tested diodes operated without any additional cooling system. In the second variant, the diodes were attached to an aluminum heat-sink with dimensions of 175 x 118 x 10 mm. In the third variant, the diodes were placed on a coldplate with dimensions of 150 x 70 x 10 mm connected to the forced cooling system.

As an example, Fig. 1 shows the dependence of the luminous flux  $\Phi_V$  produced by each of the tested diodes as a function of their forward current. In this figure, the solid lines refer to the CXB1507 diode, while the dashed lines refer to the CXB2540 diode.

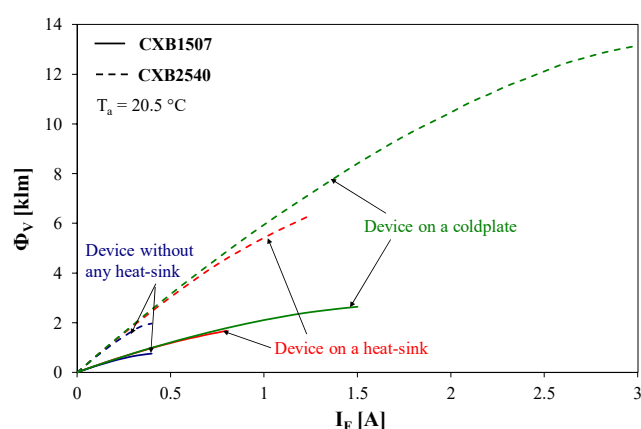


Fig. 1. Dependences of the produced luminous flux on the forward current

It is clearly visible that the maximum value of the luminous flux obtained for the CXB2540 diode is even 6 times higher than for the CXB1507 diode. This discrepancy results, among others, from the difference in the active surface of the devices under consideration and the maximum permissible value of the forward current. At the current value of  $I_F = 1.5$  A, the  $\Phi_V$  values for both diodes differ four times. The deterioration of the cooling conditions of the diodes under consideration causes a limitation of the maximum permissible value of the  $I_F$  current, and consequently – a limitation of the maximum value of  $\Phi_V$ . Additionally, due to self-heating, the value of the luminous flux corresponding to the set value of the  $I_F$  current decreases. This decrease reaches as much as 20%.

The presented measurement results indicate that the design of LEDs in COB packages and the selection of their cooling system significantly affect the electrical and optical parameters of the considered class of semiconductor devices. In further studies, the authors will attempt to prepare a mathematical description of the observed relationships.

The presented research results may be useful for designers of lighting systems. They may also be useful in teaching to illustrate to students the influence of selected factors on the parameters of power LEDs in COB packages.