

# Thermal modeling and simulation of high power LED module

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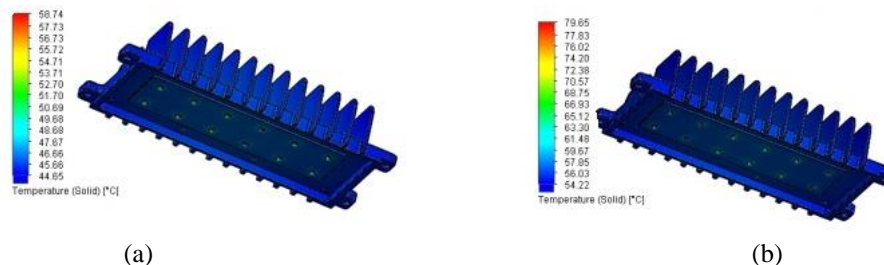
**Abstract.** The article presents the selected issues related to precise thermal modeling of the LED module using CFD software. Determining the temperature of the junction of semiconductor light sources at the stage of designing the module or luminaire is essential in the context of determining its impact on reliability, or changing the light parameters during the operation of the luminaire under real conditions. The obtained simulation research results were modified on the real object.

## INTRODUCTION

In order to work properly and maintain the consistency of light parameters of individual sources, modules, or entire luminaries with LED sources, the thermal analysis is performed to determine the temperature conditions in which luminaries work, as well as to determine the temperature of the junction of individual sources. For advanced calculations it is possible to use software based on the finite element method or computational fluid mechanics, which additionally enables taking into account all types of heat flow and the influence of external conditions on the luminaire's work [1,2]. The article presents the results of thermal research of the module with semiconductor high power light sources. For the selected LED source, the optical efficiency and the thermal resistance value between the junction and the casing were experimentally measured, which was then used for thermal simulation of the LED module, based on the CFD software. The obtained simulation results were compared with the results of experimental research.

## METHODOLOGY AND RESEARCH RESULTS

Thermal analysis of the LED module was performed in the FloEFD simulation software of the Mentor Graphics company, based on computational fluid mechanics. For the construction of the LED module 12 identical LED sources were used, for which the optical efficiency, thermal power and actual thermal resistance were determined experimentally.



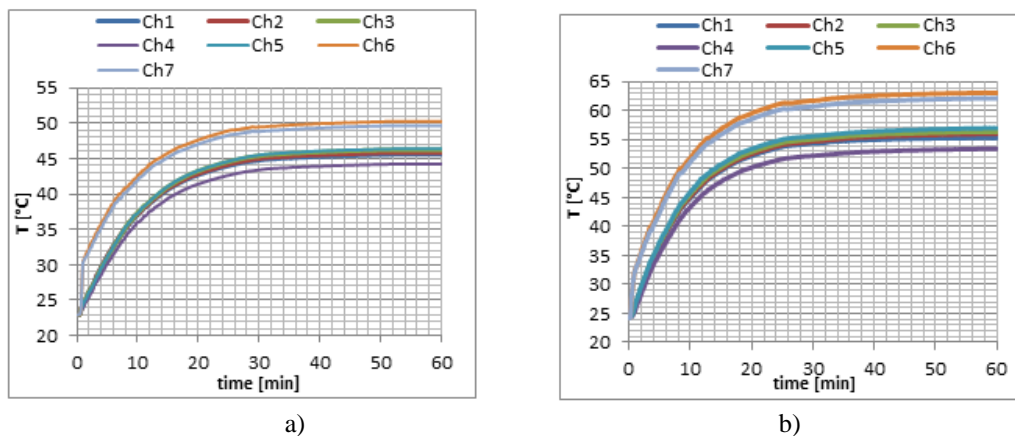
**FIGURE 1.** Temperature distribution of a simulated LED module for forward current values: a) 700mA, b) 1050mA

Thermal analysis was performed for three forward currents: 350 mA, 700 mA and 1050 mA. In order to determine the junction temperature, the previously determined thermal power for the three above currents and the real thermal resistance  $R_{thj-c}$  between the junction and the diode case were assumed for the simulation.



**FIGURE 2.** Arrangement of temperature measurement points on the tested LED module

The real temperature measurement was carried out for the tested LED module. Seven measurement channels were mounted on the radiator and the MCPCB substrate with the temperature sensor in the form of a K-type thermocouple.



**FIGURE 3.** Temperature distribution at seven measuring points on a real LED module for forward current values: a) 700mA, b) 1050mA

## CONCLUSIONS

The obtained simulation results were very close to the real results, and the highest error value did not exceed 5%. Such a low error value of simulation results indicates the correctness of the parameters measured experimentally, as well as the correct thermal model of the simulated LED module. The obtained results confirm the feasibility and validity of simulation tests related to determining the temperature distribution of the module or the luminaire with the semiconductor light sources. The temperature of the LED sources connector determined this way is also an important source of information on the correctness of the adopted cooling system for LED sources, which is the basis for effective module operation in real conditions. The presented results are part of a wider research project, developed in the future..

## REFERENCES

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