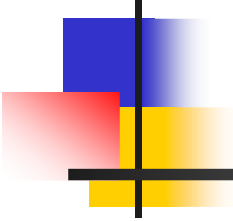


The influence of mutual thermal interactions between power LEDs on their characteristics



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Outline

- Introduction
- Model form
- Estimation of model parameters
- Results of calculations and measurements
- Conclusions



Introduction (1)

- Power LEDs are more and more commonly used in the lighting technique.
- Temperature strongly influences properties of these diodes, particularly their lifetime.
- Due to a low value of the luminous flux emitted by a single diode, more frequently, the circuits containing more diodes situated on the common basis (the printed circuit board or the heat-sink) are used.
- Therefore, the value of the internal temperature of the LED depends on the ambient temperature, self-heating phenomena in the diode and mutual thermal interactions between the diodes situated on the common basis.
- For the purpose of the analysis of properties of the system containing LEDs before constructing such a system or optimising its construction, the computer-aided analysis of electronic circuits is used.

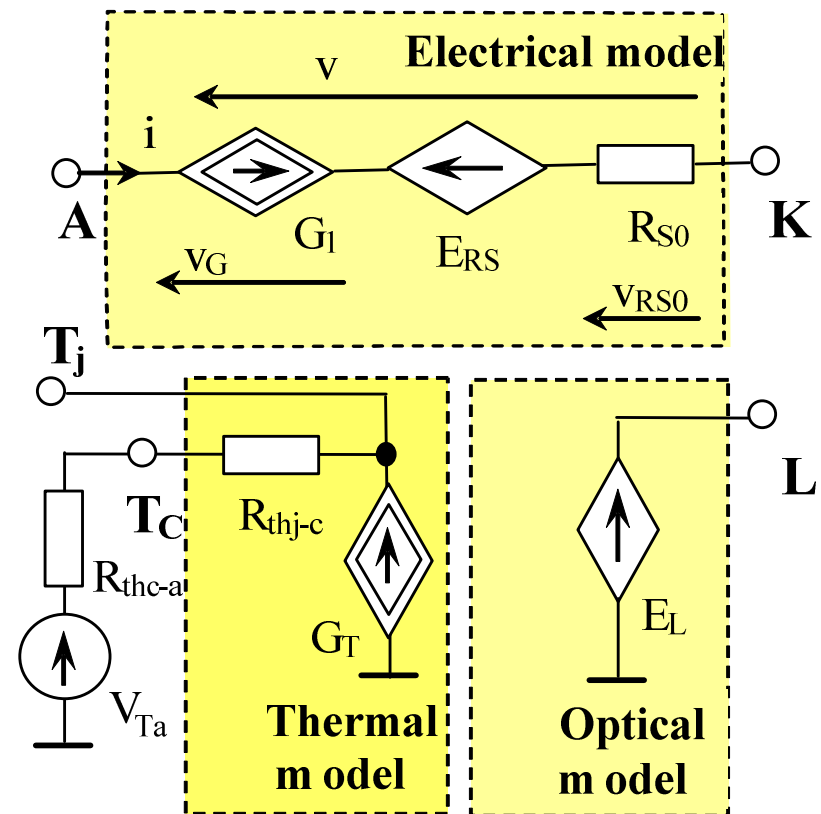


Introduction (2)

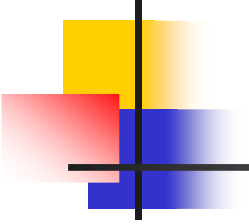
- In such an analysis the electrothermal model of the power LED is indispensable.
- Very often such an analysis is realized with the use of the SPICE software.
- In the paper, the new electrothermal model of the power LED dedicated for the SPICE software is proposed.
- This model takes into account, apart from self-heating phenomena, the mutual thermal interactions between the devices situated on the common basis.

Model form

- The model belongs to a group of compact electrothermal models
- 3 parts of the electrothermal model:
 - the thermal model
 - the electrical model
 - the optical model
- the reverse current and breakdown phenomena are omitted in this model.
- Detailed description – see proceedings

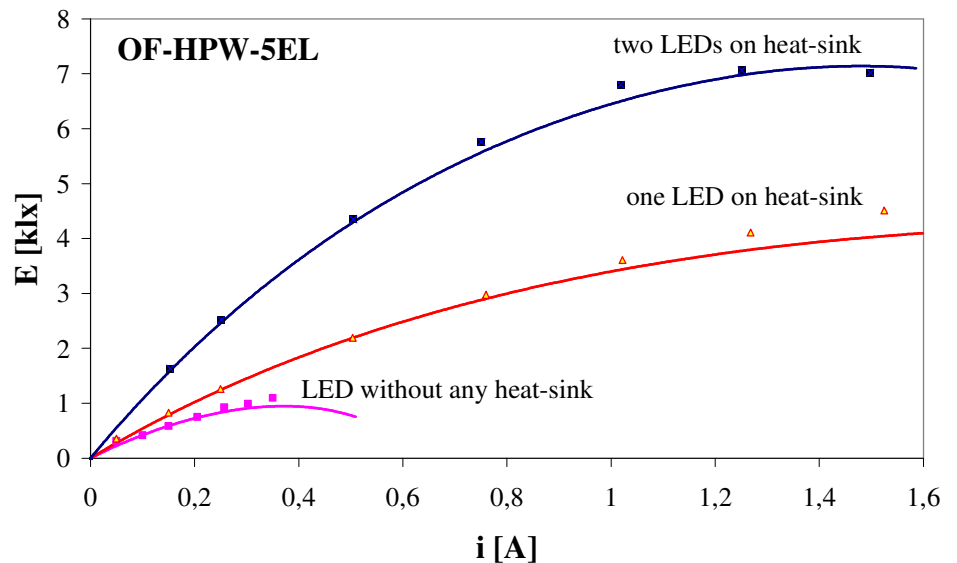
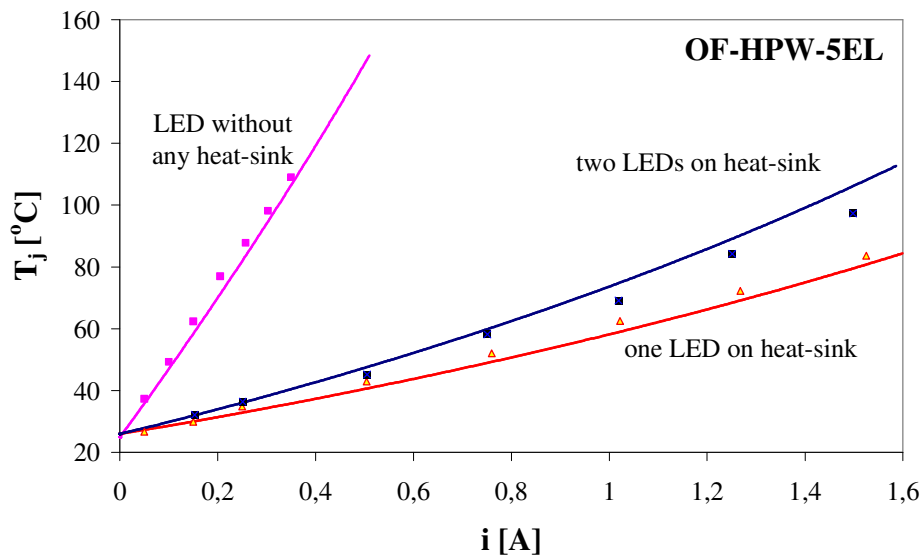


Estimation of model parameters

- 
- 4 electrical, 5 optical and 3 thermal parameters
 - Local estimation algorithm
 - Measurements of $i(v)$ characteristics at 2 values of the ambient temperature
 - Measurements the dependence of illuminance on temperature
 - Calculations of electrical and optical parameters (detailed equations – see proceedings)
 - Measurements of the own and mutual thermal resistances of the investigated LEDs and between these LEDs

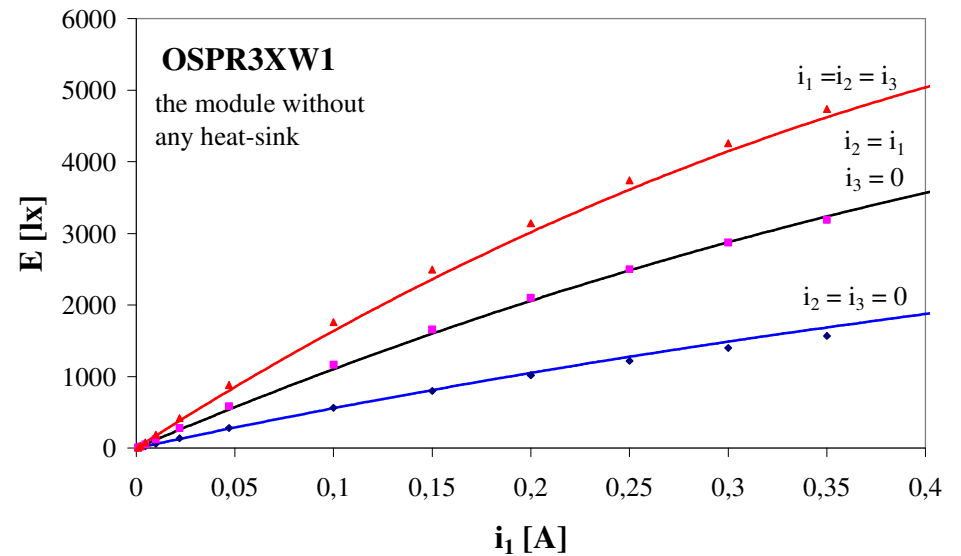
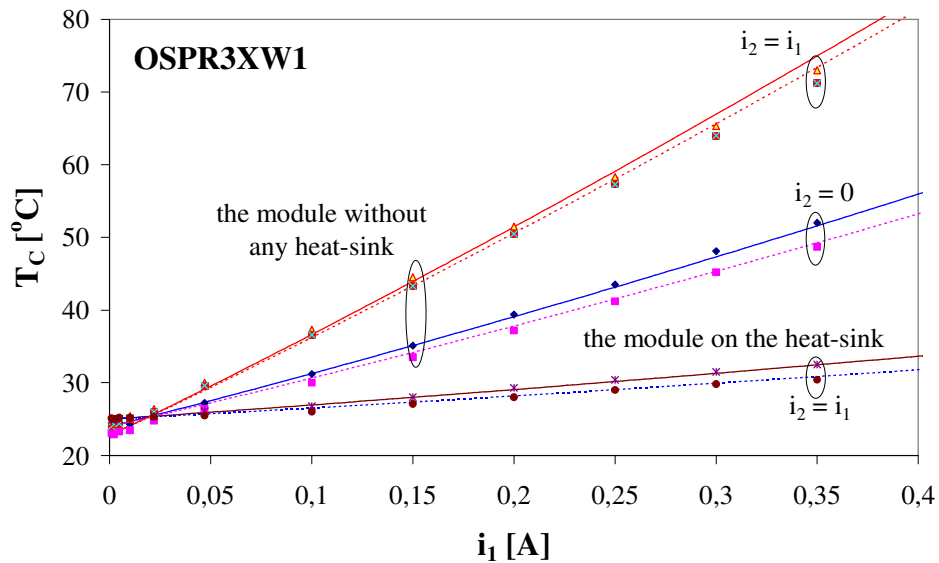
Results of calculations and measurements

■ 2 LEDs OF-HPW-5EL



Results of calculations and measurements

- the module OSPR3XW1 with 3 LEDs





Conclusions

- In the paper the electrothermal model of the power LED taking into account its electrical, optical and thermal properties is proposed.
- This model makes it possible to consider the mutual thermal coupling between the devices situated on the common basis.
- The worked out model has a simple form, adequate to typical uses of the modeled device.
- The proposed manner of estimation of the parameters values of the model is not complicated and demands realizations only of the simple measurement and calculations.
- The characteristics obtained by means of the worked out model fit good the results of measurements both for single power LEDs and LED modules operating at different cooling conditions.



Conclusions (2)

- The results of calculations and measurements prove that the mutual thermal coupling between power LEDs strongly influences the forward voltage of these devices, their junction temperature and the power of the emitted light.
- An increase of the forward current of the diode can cause a fall in the value of the illuminance of the surface lighted up by the LED. This is the result of the excessive rise of the junction temperature of the diode due to thermal phenomena.
- If the spatial conditions let this, then, from the point of view of the system efficiency, it is more profitable to use the modules containing several LEDs operating at the smaller value of the forward current than single LEDs operating at the large forward current.