TEMPERATURE TESTS OF LED LIGHT SOURCES

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Abstract: The article compares the effect of high ambient temperatures on LED retrofits. The nine measured samples examined the change of electrical and light technical parameters and eventual permanent high temperature damage. The comparison was made both from the point of view of the energy and the quality of the light produced, both among themselves and with the parameters specified by the producer.

Keywords: LED light sources, temperature test, permanent damage

1 INTRODUCTION

Lighting technology for LED light sources has been undergoing a very dynamic development and price reduction in last years. Like other light sources, LED light sources have their own features that are needed when designing lighting systems when replacing other light sources in older luminaires. Thanks to their high light efficacy, low power consumption, environmental performance and variety of design, LED technology is used in modern interiors as well as in conventional luminaires, where only light sources can be replaced. Dimensions, ease of use and long service life allow architects and designers to work with this type of light source just like never before. LED light sources can serve as the main lighting element in the room as well as a complementary element that creates a certain light scenery. They also find use in the industry, whether to replace fluorescent tubes or halogen lamps. In the area of street lighting, due to the exact determination of the illuminated area, the effect is not only on consumption but also on the limitation of light smog. [1]

2 TYPES OF LED CHIPS

Historical developments have created several types of cases for light emitting diodes. The development of the housing is evident, mainly by increasing the performance of the LEDs and improving the residual heat output, passing it over to the radiator or the surroundings, as shown in Fig 1.

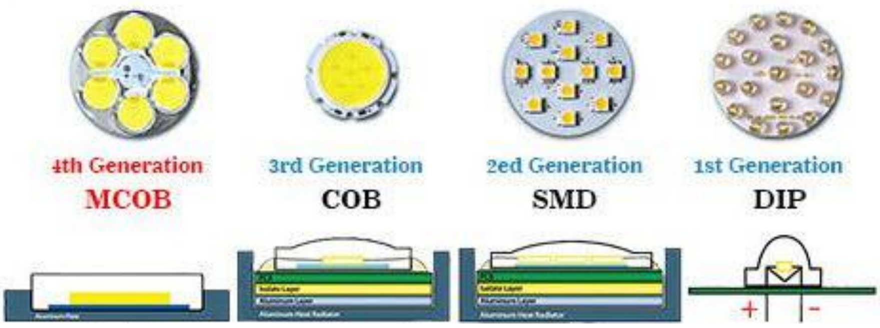

Figure 1: Types of LED chips [2]

2.1 DIP LED

DIP (Dual in-line package) is the oldest case of the LED, the oldest case, this is a PN transition to a substrate, placed on robust metal surfaces that pass through the sump. The plate, including the substrate, is embedded in plastic. Designed to be very resistant to mechanical damage, the transition itself is also protected against moisture. The specific luminous power of this type varies from 35 to 80 lm / W depending on the type. [3]

2.2 SMD LED

Surface mounted device (SMD) is a modified version of the DIP led for surface mounting. The PN gradient substrate is again embedded in plastic. Transparent is only a part of the case, and there is a much thinner layer of plastic between the PCB and the PN transition itself, which partially improves the heat transfer and its transfer to the printed circuit. The specific light output or type of this type varies according to the type in the range of 50-100 lm / W [3]

2.3 COB LED

COB (Chip on board) is a production technology where multiple LED chips are stored in one case and form a single module. Compared to the previous version, the SMD LED has higher light output and lower thermal resistance of the heat path between the PN transitions and the cooler. Often, the COB LEDs are delivered directly to the aluminum base for better heat dissipation, this set can be easily attached to the radiator. The specific luminous power of this type varies from 80 to 100 lm / W [3] [5] depending on the type.

2.4 MCOB LED

MCOB (Multiple chip on board) developed from COB LED, a very similar technical solution. The MCOB LED consists of individual PN transitions, spaced in a predetermined area, usually in a matrix. The benefit of this technology is the multiple increase in luminous flux.

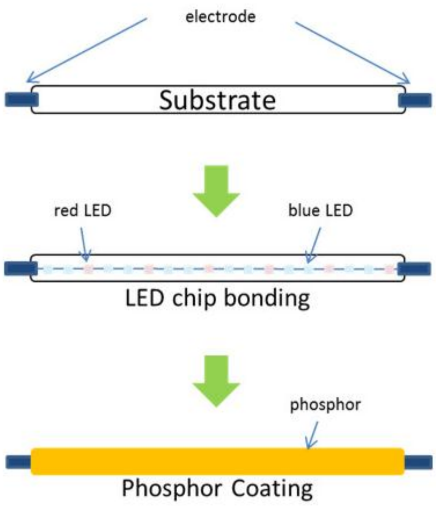

Figure 2: Construction of filament LED module [7]

2.5 FILAMENT LED

This type of case is one of the newest, one of its tasks is to imitate in a glass bulb the fiber of a classic bulb. The LED forms a narrow, long strip of substrate, in which several PN transitions are placed in series, the surface of the tape is covered with a luminofor, as can be seen in Fig. 2. The entire LED retrofit is a series or series-parallel combination of four or six individual filaments. The heat transfer from the PN transitions itself is either via conduction through the substrate and the inlets, or through the gas that the LED retrofit is filled with. [4] [6]

3 MEASURING METHODS

Extreme conditions in the operation of LED light sources are most often operating at a high temperature around the light source. It can be encountered, for example, in the case of a closed LED light source, for example, in a luminaire lamp or LED light source installed in production halls under the roof structure where, depending on the type of operation in the hall, the ambient temperature can vary by more than 70 °C. The illuminated LED light source is placed in a test chamber and the ambient temperature is gradually increased up to 120 ° C. At this temperature, the LED properties of the chip should be negative and at the same time the light source construction should not be affected by the temperature. During the heat test, only the temperatures in the test chamber space and the temperature on the heat sink, or in close proximity to the LED of the light source cc, can be measured. Photometric parameters are measured before and after the heat test. The difference between measurements under the same conditions reveals the degree of permanent damage to the light source LED, or even the power supply, and the effect on the guaranteed life of the light source.

4 MEASUREMENT PROCEDURE

For all light sources, the spectradiametr was gradually measured, and the other photometric variables were transferred from the spectrum. For each measured light source, the electrical parameters were also measured using a programmable source over which the measured light source was powered. After measuring the electrical and lighting technical parameters of all the light sources, thermocouples were mounted on individual heat sources on the cooler and near the LED chip, which measured the temperature at the given points of the light sources in a contactless and negligible response.

In the first phase, the objective was to find out how the light sources were warming under normal conditions and normal temperature, therefore they were connected to the supply voltage and their heating characteristics were measured at ambient temperature θ_0 = 25 °C. After all temperatures had stabilized, the light sources were disconnected from the power supply and the cooling rates were measured. In the next phase, the warming characteristics of the light sources connected to the artificial ambient temperature supply were measured by means of the climatic chamber. The initial ambient temperature was -15 °C. The temperature was gradually set at 50 °C, 60 °C, 70 °C, 80 °C. After the temperature has stabilized at ambient temperature θ_0 = 80 ° C, the light sources have been disconnected from the power supply and the ambient temperature in the climactic has been set to 120 °C. Because it was an objective to test how long the LED chip, luminophore and power supply could cause a high temperature.

5 MEASUREMENT EVALUATION

The measurement was subjected to a total of nine LEDs listed in the list, two of which were of the same type from the same manufacturer, bought in half a year.

Z 1 – LED retrofit filament LIVARNO	4 W,	420 lm,	2700 K
Z 2 – LED retrofit LED STAR OSRAM	8 W,	806 lm,	2700 K
Z 3.1 – LED retrofit IKEA,	11 W,	600 lm,	2700 K
Z 3.2 – LED retrofit IKEA	11W,	600 lm,	2700 K
Z 4 – LED retrofit AIGOSTAR A55	9 W,	720 lm,	3000 K
Z 5 – LED retrofit LIVARNO	10 W,	806 lm,	2700 K

Z 6.1 – LED retrofit AFIMO 5 W, 3500 K

Z 6.2 – LED retrofit AFIMO 5 W, 3500 K

Z 7 – LED retrofit LED LABS 8 W, 650 lm, 3000 K

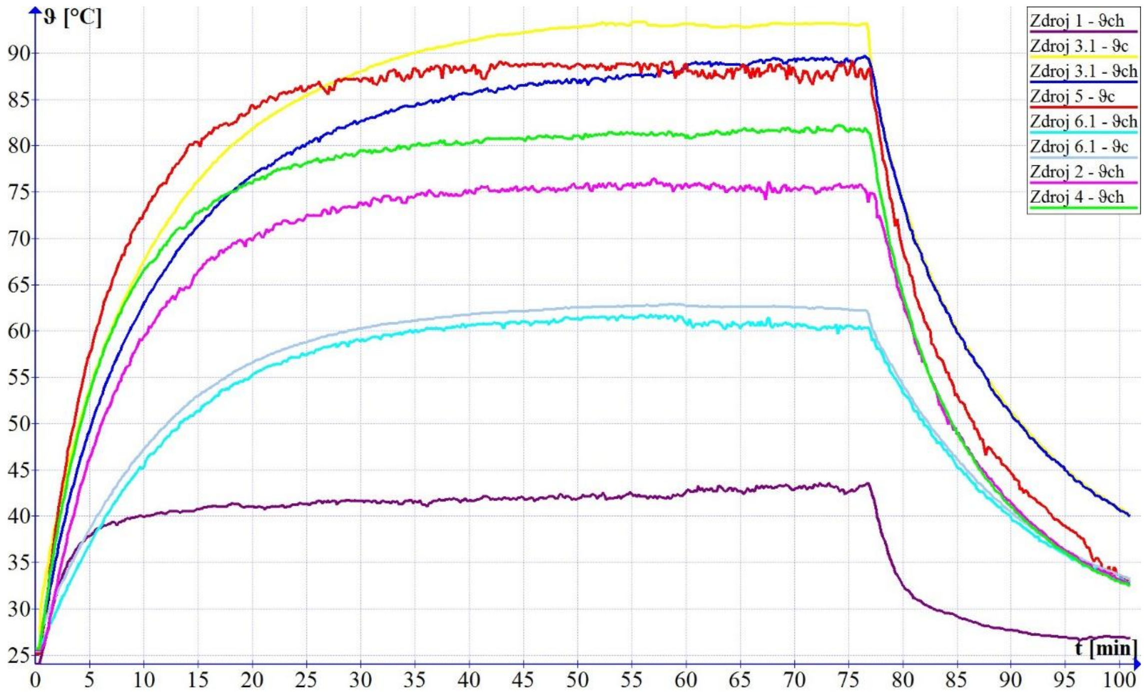

Figure 3: The temperature measurement at the measured points of the individual light sources at ambient temperature θo = 24 °C measured by the ALMEMO 5690-2

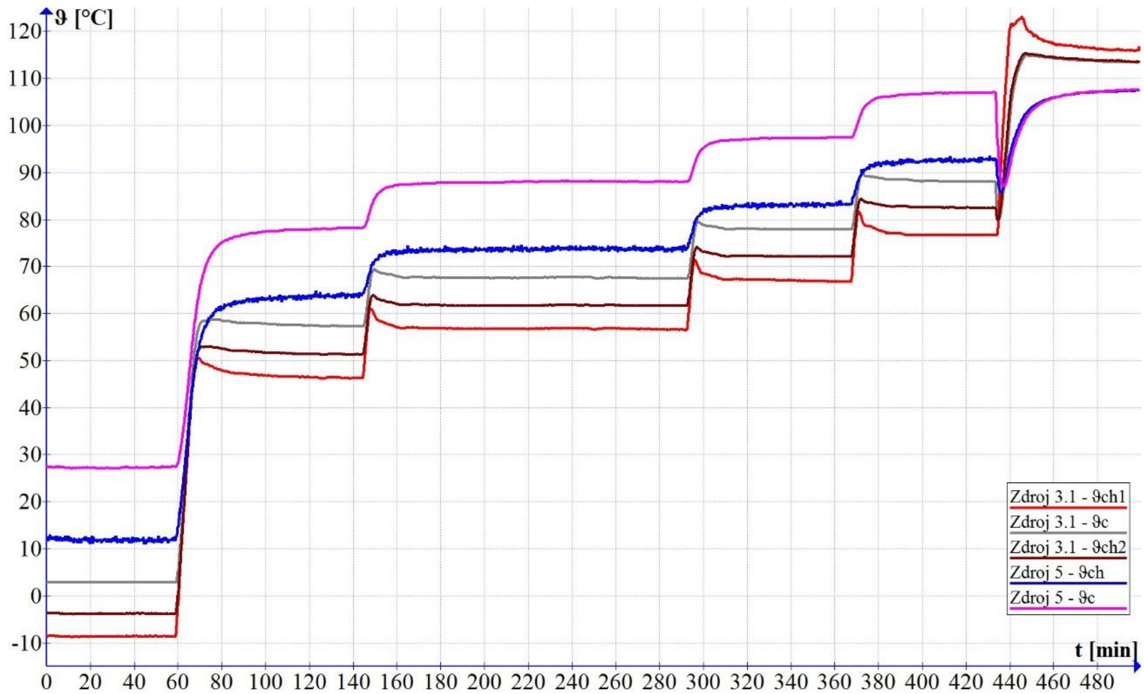

Figure 4: The temperature of the measured points of light sources 3.1 and 5 at ambient temperatures θo = -15, 50, 60, 70, 80, 120 °C, measured by ALMEMO 5690-2

Figure 3 shows the heating and cooling characteristics of the measured light sources at an ambient temperature of 25 °C. It is apparent that the measured sources have a design solution to heat dissipation from the LED chip differently. At sources 1 and 5, the temperature near the LED chip reaches a temperature of around 90 °C. On the other hand, the source 6.1 has better heat dissipation and the temperature near the LED chip cc does not exceed 65 °C, which is much lower temperature than other sources coolers. For other sources, the temperature relative to the construction was measured only on the cooler. Significant overheating and insufficient heat removal were found at source 3.1. the temperature difference near the LED chip and on the heat sink reached less than 5 °C and overall exceeded the temperature near the chip over 90 °C.

Measurement of temperature characteristics at various ambient temperatures is based on placing the light source in the temperature chamber and connecting to the supply voltage. The ambient temperature was gradually increased from -15 ° C to 50 °C, 60 °C, 70 °C, 80 °C. Increasing the ambient temperature allowed time to stabilize the temperatures at the measured points. In the last step, the light sources were disconnected from the power supply and the temperature in the temperature chamber was increased to 120 °C. The graph in Fig. 4 shows the effect of removing the heat source in the form of LED chip and how some temperatures drop sharply.

6 CONCLUSION

After verifying the parameters of new light sources, these light sources were subjected to a thermal test in the thermal chamber according to the proposed measuring chain. Its aim was to inspect the thermal characteristics of the individual sources and the way heat is drawn from the LED chips, and also to expose the entire LED retrofit to a high temperature, in which the individual parts of the sample may partially or completely be damaged.

After the heat test, all lighting and electrical parameters were measured in the same way so that they could be compared. Luminous sources were deliberately chosen in a variety of ways to compare products of different types. The expected results were achieved in the case of long-term exposure of the measured light sources to high temperatures, it is assumed that the damage would be manifested more.

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