SPECTRUM ANALYSIS OF DAMAGED LED LIGHT SOURCES

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Abstract: Permanent damage to LED chips, often high temperature is one of the common problems. The article compares the spectrum of LED retrofits before and after permanent high temperature damage. Several different samples tested were damaged by the same defined temperature during operation. The radiated spectrum was measured before and after exposure to the temperature and subsequently evaluated.

Keywords: LED light sources, LED retrofit, permanent damage

1 INTRODUCTION

The LED lighting industry has been undergoing very dynamic development and price reductions in last years. Like other light sources, LED light sources have their specific features to be taken into account when using lighting systems when replacing other light sources in older luminaires. Thanks to their high luminous efficacy, low power consumption, ecological operation and variety of designs, LED technology has recently been used in modern interiors as well as in conventional lights, where it is often enough to replace only the light source. Dimensions, ease of use and long life allow architects and designers to work with this type of light source as never before. LED light sources can serve as the main lighting element in the room, as well as an additional element creating a certain light scenario. They also find application in the industry, either as a replacement for fluorescent tubes or as halogen lamps. For interior luminaires, Filament LEDs are coming to the forefront to replace the bulb. In the field of street lighting, due to the precise determination of the illuminated area, they influence not only power consumption but also the reduction of light smog. [1] [2]

2 MEASURING METHODS

One of the common ways of permanent damage to the LED chip is its long-term exposure to high temperature, deforming both the LED chip itself and the spectral properties of the luminophore to which it is covered. Poor influence on the whole light source is also high temperature on the power supply, for example in retrofit. This example can be seen, for example, in the case of a closed LED light source, for example in a lamp bulb, in which the waste heat generated by the LED during its operation is prevented. Another example is the LED light source installed in production halls under the roof structure, where the ambient temperature ϑo can be as much as 70 °C depending on the nature of the traffic in the hall and the season. The light source spectrum was measured before and after exposure to high temperature. The light source was operated at an ambient temperature of 120 °C for 30 minutes. Negative properties of the LED chip should be exhibited at this temperature and at the same time the design of the light source should not be impaired by the temperature. During the heat test, only the temperatures in the test chamber space ϑo and the temperature on the radiator ϑr or in close proximity to the light source LED can be measured ϑ_c. [4]

3 MEASUREMENT PROCEDURE

All measured light sources were gradually inserted into a spherical integrator, where the spectrum radiated by the measured light source was measured by a spectroradiometer and subsequently further photometric quantities, mainly luminous flux, were transferred from the spectrum. Among other things, electrical parameters were also measured for each measured light source using a programmable source through which the light source was powered. After measuring these parameters, all the light sources measured were exposed to a temperature of 120 °C for 30 minutes. The light sources were connected to the rated supply voltage during the test. After the test, the radiated spectrum was again measured in all light sources and compared to the spectrum before the thermal load. [3]

4 MEASUREMENT EVALUATION

Seven LED light sources were subjected to measurements.

Source 1 – LED retrofit filament LIVARNO	4 W,	420 lm,	2700 K
Source 2 – LED retrofit LED STAR OSRAM	8 W,	806 lm,	2700 K
Source 3 – LED retrofit IKEA	11W,	600 lm,	2700 K
Source 4 – LED retrofit AIGOSTAR A55	9 W,	720 lm,	3000 K
Source 5 – LED retrofit LIVARNO	10 W,	806 lm,	2700 K
Source 6 – LED retrofit AFIMO	5 W,		3500 K
Source 7 – LED retrofit LED LABS	8 W,	650 lm,	3000 K

The measured spectrum that a given light source emits is the basis of all other light-technical parameters, most of which come out of it, can be calculated or derived from it. The following graphs show not only how the different types of light sources and different light sources of the same type differ (COB, MCOB, filament LED). There is a visible comparison of the spectra at the moment of switching on the light source and after stabilizing the values, as well as the effect of the heat test and its effect on spectrum change. A typical LED spectrum consists of two regions, one in the blue region and the other in the region of warmer tones (longer wavelengths). The size ratio of these regions gives the resulting color temperature of the light source. When the first region prevails over the second, it means that the LED used in the light source radiates more energy directly and less transforms through the luminophore, the resulting color temperature reaches higher values, and the viewer then appears to be a cool white light source. In the opposite region, larger amounts of radiation are transformed into longer wavelengths and the color temperature reaches lower values. The light source appears warm white.

In several cases (source 1, 2, 4, 5), it is apparent from the measured values that the exposure of the LED retrofits at a high temperature has only a minor effect on the spectrum change, as shown in Figure 1. The light source spectrum is shown immediately after being connected to the light, the light red is the spectrum after stabilization of parameters. Dark shades represent the spectra after the heat test, blue again after the connection to the power and red after the stabilization of the parameters Significant spectrum changes due to the high temperature during the temperature test occurred in sources 3, 6 and 7, the shift of the spectrum mainly in the area of longer wavelengths is visible in Fig. 2 , within the whole spectra then in Fig. 3. For other spectra, high temperature only caused the courses to be not as smooth as before the heat test.

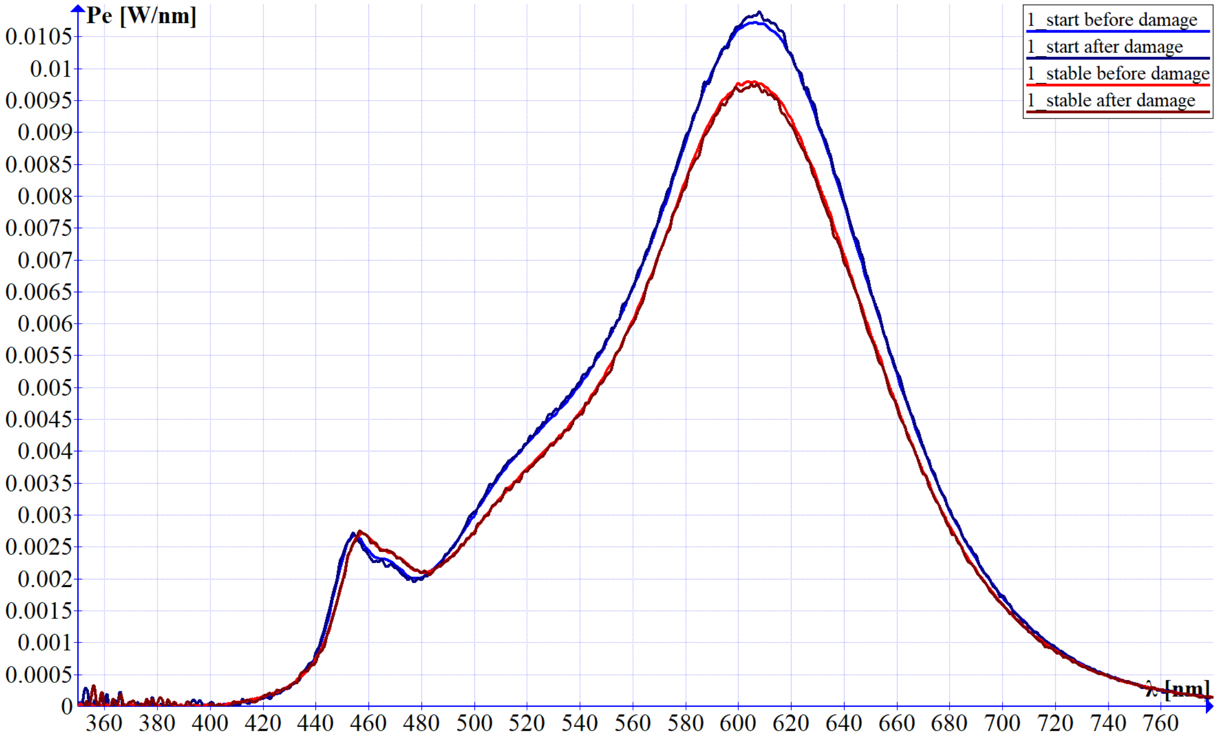

Figure 1: Demonstration of spectrum shift new and damaged LED_1 at start and after luminous flux stabilization

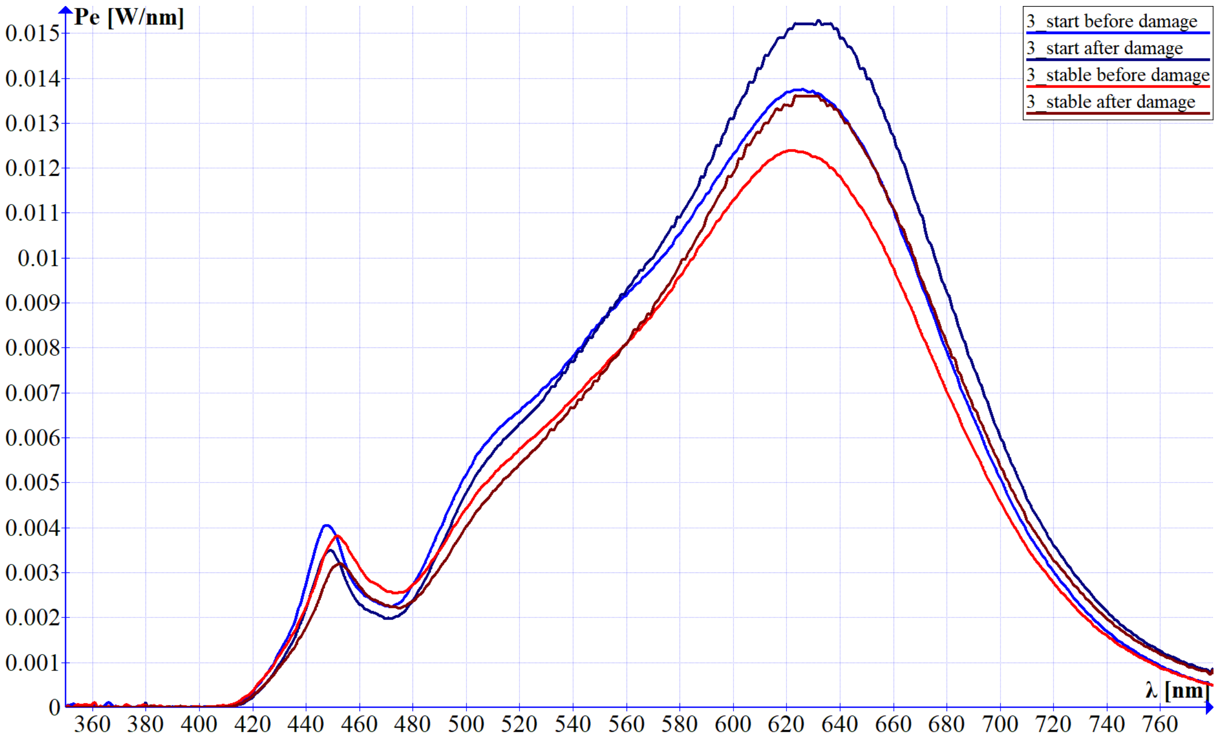

Figure 2: Demonstration of spectrum shift new and damaged LED_3 at start and after luminous flux stabilization

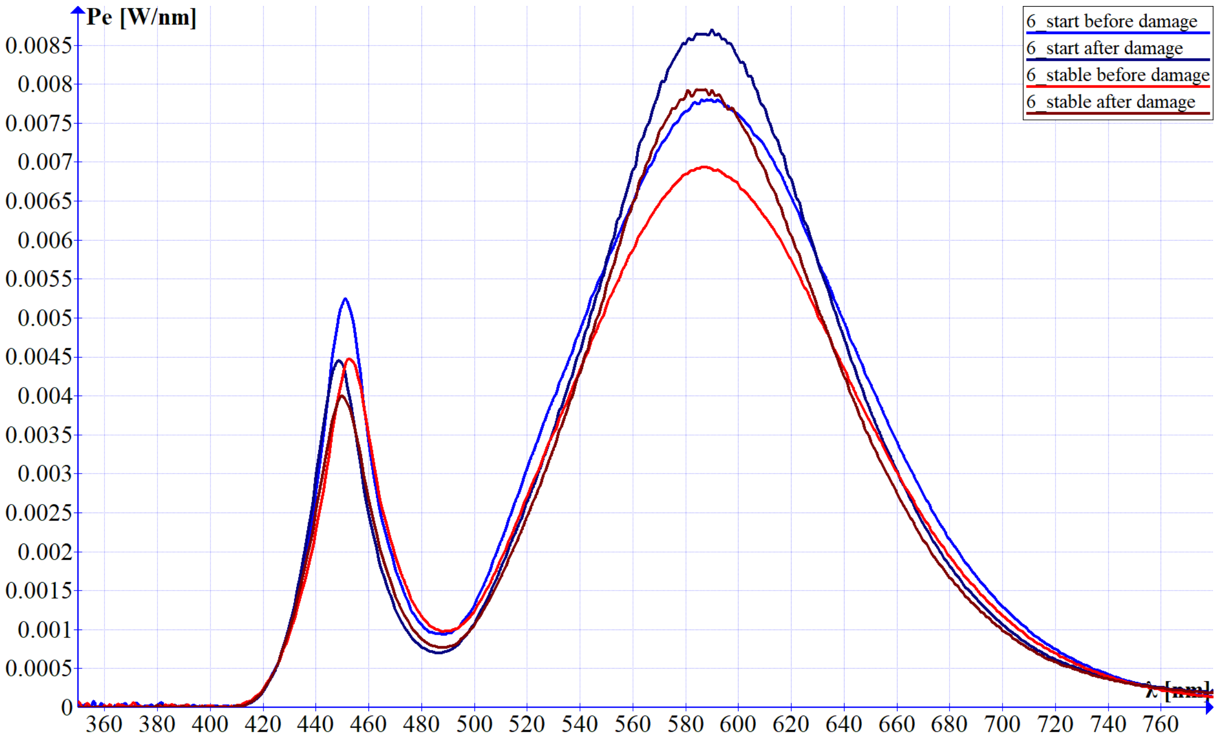

Figure 3: Demonstration of spectrum shift new and damaged LED_6 at start and after luminous flux stabilization

5 CONCLUSION

The spectrum emitted by the measured LED light sources was measured before and after the heat load, which permanently damaged the LED chip, both the transition itself and the luminophore. In some cases, there has been a significant shift in spectrum or a change in radiated energy at some wavelengths, in other cases there has been only a slight ripple, but there have been no spectral shifts. It is also apparent from the graphs that even with the largest differences in spectra, this difference is comparable to the difference in spectrum at start-up and after steady light flux of the source. The heat most damaged were usually light sources of unknown or less known producers.

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